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LIFE HISTORY OF POTAMOGETON CRISPUS[1]

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Potamogeton crispus L., curly pondweed, is a perennial, herbaceous, submersed aquatic plant of Eurasian origin. It arrived in the United States early in the nineteenth century and is now spreading aggressively throughout the country (Stuckey 1979). Published data on the biology of *P. crispus* are fragmentary and sometimes erroneous. The need for accurate and comprehensive information on its life history prompted this study during the 1970's. Since then an extensive review has been presented on the biology of *P. crispus* (Catling & Dobson 1985).

The concept of a life history has a broad spectrum of interpretations. Gupta (1934), for example, treated the life history of *P. crispus* strictly in terms of morphology of the anther, embryo sac, and embryo and their development. Our study describes the seasonal growth forms, develops the vegetative and sexual cycles from studies of plants in the field, laboratory, and herbarium, and assesses the environmental parameters in the initiation of the plant's growth forms.

FIELD OBSERVATIONS

Observations and measurements of plants were made at various times of the year at several localities in central and northern Ohio and southeastern Michigan during late 1976, 1977, and early 1978. The year-round study site was in central Ohio, at the Delaware Reservoir Wildlife Area north of Delaware, or 67 km (42 mi) north of Columbus, between U.S. Routes 23 and 42. In that area, approximately 50 ponds were constructed in 1953–55 by damming small streams (Ross 1974). Most observations were made in ponds numbered 1 and 1B, which contained vigorous vegetative and flowering populations of *P. crispus*. The ponds had mud bottoms at depths of one to two meters, and were surrounded by willows, elms, maples, cottonwoods, and cattails.

VEGETATIVE GROWTH FORMS

During the year, *Potamogeton crispus* produces two kinds of vegetative growth forms: plants with spring foliage formed after disappearance of ice

[1]Condensed from an M. S. thesis, titled, "An ecological life history of the pondweed *Potamogeton crispus* L. in North America" completed in the Department of Botany and submitted to the Graduate School of The Ohio State University, Columbus, 1978. 157 pp. Reprinted in its entirety as Clear Technical Report no. 99. Center for Lake Erie Area Research, The Ohio State University, Columbus, Ohio. 1978.

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cover, and plants with winter foliage formed under the ice (Fig. 1A; Ascherson & Graebner 1907, p. 98, Fig. 23D). Spring foliage is typically illustrated and described in floras and botanical handbooks. The leaves are characteristically red-brown, somewhat broad at 0.75–1.5 cm wide, and 3–8 cm long, brittle, and thick. They vary from the most commonly encountered oblong shape to ones with acute tips and others tending toward an obovate shape. The leaves are sessile, two-ranked, regularly undulate with serrulate margins. Three to seven veins are present, with a prominent midvein that is widest near the base and dark-red. Another vein, less prominent than the midvein but more prominent than other lateral veins, typically extends about 1.5–2 mm from the margin. In the case of somewhat narrow leaves, this vein is at a distance of one-third the width of the leaf from the margin. Winter leaves are somewhat narrow, 0.5 to 0.75 cm wide, flexuous, blue-green, with acute tips and a red-brown midrib, with at best weakly undulate and very irregularly serrulate to entire margins.

Dormant apices of *P. crispus* are perennating, dispersal structures developed as modifications of either stem tips, subapical stem portions, and/or subapical leaves. Typically, a single dormant apex includes 5–7 buds, with one bud per leaf axil, each of which can break dormancy and give rise to a viable shoot. Dormant apices are formed from either terminal, or more commonly, axillary stem tips. Clos (1856) appears to have been the first author to characterize these dormant apices and describe their production.

A typical mature dormant apex consists of several lobes projecting laterally from the central axis. These lobes are expanded bases of leaves. As a stem tip becomes modified into a dormant apex, the upper portion of each leaf remains essentially unmodified. The basal, approximately two-thirds of each leaf, on the other hand, becomes greatly modified. The width and thickness of the base increases much more than the distal portion of the leaf. In addition, serrations of the leaf margin increase in size and give the dormant apex a thorny appearance. In early stages of development the apex is olive-drab, dark-brown, or nearly black. Before maturation is complete, however, the unmodified distal portions of the leaves decay and eventually disappear. What remain are the red-brown, thickened, broadened, toothed leaf bases attached to an enlarged stem axis. The density of dormant apices produced in a growing season can be quite high. Bottom samples taken at various times of the year from the two ponds at the Delaware Wildlife Area revealed that the mean number of dormant apices per dredge, among 11 samples examined, was 63.1 per 413 cm^2. The minimum number in any dredge was 10, and the maximum was 89.

VEGETATIVE REPRODUCTIVE CYCLE BASED ON FIELD PLANTS

A diagrammatic representation of the vegetative growth forms as a function of the season of year shows the yearly cycle of the three fundamental growth forms: spring foliage, the dormant apex, and winter foliage (Fig. 1).

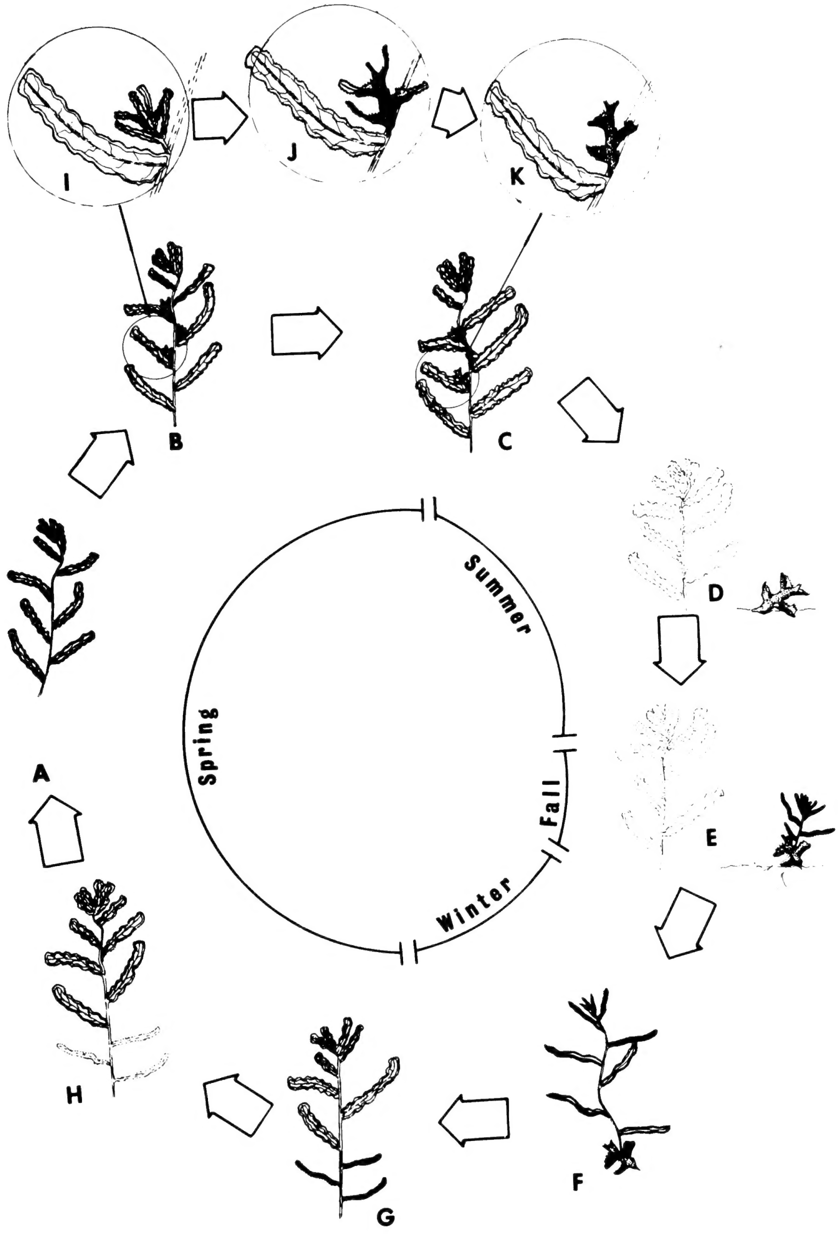

FIGURE 1. The vegetative life cycle of *Potamogeton crispus* based on field observations. 1A, plant bearing spring foliage; 1B, plant bearing spring foliage, with outgrowth of lateral shoots; 1C, plants with axillary dormant apices forming; 1D, dieback of spring foliage, and detached mature dormant apex; 1E, germinating dormant apex, early stage; 1G, plant bearing older winter foliage and new spring foliage; 1H, older winter foliage disappearing; 1I-1K, magnified view of forming axillary dormant apex.

After ice melt in late March and early April, undulate serrulate-margined spring leaves become fully developed (Fig. 1A), and flower bud induction begins. Almost simultaneously with flower bud initiation, in mid-April, axillary buds break dormancy (Fig. 1B), probably because of a loss of apical dominance after floral induction. The drawings of a leaf, leaf axil, and axillary shoot illustrate the formation of a dormant apex from an axillary shoot (Figs. 1I, 1K). The basal portions of leaves contributing to an incipient dormant apex in addition to the apical stem portion become swollen with high-energy storage products (Moore 1913), and when mature the dormant apex sinks to the substrate surface.

Following production and abscission of mature dormant apices, from late May through mid-August, dieback begins of plants bearing spring foliage (Figs. 1D, 1E; Rogers & Breen 1980). This dieback occurs as a function of the warming of the water. High water temperature is one of the environmental constraints necessary for the formation of dormant apices. To an extent, cooler water delays production of dormant apices. This delay allows continued activity of terminal and/or axillary meristems which, in turn, allows the plant to remain alive in a leafy vegetative state. In contrast, in warm water, dormant apices are formed early in the season at all apical meristems, thus making use of all positions of active cell division and causing death of the parent plant.

The fall period, late September through late November, is characterized by a rapid decline in water temperature in small ponds. Germination from axillary buds of dormant apices begins at this time (Fig. 1E). Germination in the wild usually occurs only from a single axillary bud, although every bud potentially can germinate. The foliage produced is of the winter type, and all foliage remaining from the previous season dies back by this time (Fig. 1E).

The winter season extends from mid-November through early March. *Potamogeton crispus* persists in a vegetative condition in spite of harsh environmental conditions, including low water temperatures ranging from 1–4°C, and low incident light intensity because of heavy snow and ice cover (Stuckey et al. 1978). An illumination of 140 or fewer foot candles just below the ice cover on a cloudless day is considerably less than the 2200 foot candles shining above the ice. Leaf morphology is of the winter type (Fig. 1F). Because of the persistence of green leafy stems bearing winter foliage, plants overwintered under an ice cover of 12 inches in 1977 and 20 inches in 1978 and a snow cover of five or more inches each year.

With ice melt in March and increasing water temperatures, stem axes which had persisted in the flat-leaved, winter form begin production of the undulate, serrulate-margined spring leaves at the stem apices (Fig. 1G). The spring leaves on the stem axis soon exceed the winter leaves in number. Shortly after the onset of spring leaves, winter leaves begin to decay (Fig. 1H), resulting in a stem axis with primary spring foliage by late March and early April (Fig. 1A). The earliest dates on which each vegetative growth form was observed are recorded in Table 1.

TABLE 1. Earliest dates on which vegetative growth forms were observed in the field.

Figure	Vegetative Growth Form	Date of Observation
1A:	Spring foliage	16 April 1977
1B:	Outgrowth of lateral shoots	19 April 1977
1C:	Dormant apices forming	30 April 1977
1D:	Dieback of spring foliage; detached mature dormant apices	19 May 1977
1E, F:	Germinating dormant apices	Sept. 1976; 10 Oct. 1977
1G:	Plant bearing older winter foliage and new spring foliage	25 March 1977; 15 April 1978
1H:	Older winter foliage disappearing	16 March 1977; 7 May 1978

VEGETATIVE LIFE CYCLE BASED ON HERBARIUM PLANTS CORRELATED WITH FIELD OBSERVATIONS

METHODS

For broader geographic generalizations of selected aspects of the life cycle of *P. crispus*, 388 specimens obtained from 10 herbaria throughout the United States were studied with reference to growth forms which they exhibited at various times of the year. The characters selected and their accompanying observations from the herbarium and field plants are given in Table 2.

RESULTS AND DISCUSSION

Undulate serrulate-margined leaves on the herbarium plants occurred in the greatest abundance in spring and summer, especially during the first two weeks of April. Flat entire-margined leaves were predominant on plants obtained during the fall season. Accordingly, herbarium specimen data correlates well with field observations.

Herbarium plants showed a maximum leaf width in early spring and a more or less uniform decrease through the summer. This apparent trend was not noted nor studied among the plants in the field. A different situation was observed in the field plants where an alternation exists between two width classes with wide leaves in spring and summer versus narrow leaves in fall and winter. The width of winter leaves could not be ascertained from herbarium specimens because no collections had been made during the winter months.

Field and herbarium observations correlate well seasonally with regard to leaf length. Peak values for mean leaf lengths of herbarium plants occur in May and early June (among dates for which sufficient data exists). Plants observed in the field also reveal that maximum leaf lengths occur in the spring.

The remaining characters deal with the presence or absence of dormant apices and the stages of their development. Peak production of dormant apices, as indicated by herbarium plants, occurs from early June through

TABLE 2. Observation of vegetative growth forms from herbarium and field plants

Vegetative Growth Forms	Herbarium Observations	Field Observations
Leaf blade:	undulate: April-July	undulate: March-May
	flat: Sept.-Nov.	flat: Sept.-March
Leaf margin:	serrulate: April-July	serrulate: March-May
	entire: Sept.-Nov.	entire: Sept.-March
Leaf width:	"wide" ($>$5mm): May-Aug.	"wide": March-May
	"narrow" ($<$5mm): Aug.-Oct.	"narrow": Sept.-March
Leaf length:	mean $>$4cm: May-June	mean $>$4cm: April-May
	mean $<$4cm: Aug.-Oct	mean $<$4cm: Sept.-March
Presence of ungerminated dormant apices:	most abundant: early June-early Aug.	most abundant: May
Presence of germinated dormant apices:	most abundant: late Sept.-late Oct.	most abundant: Sept.-March

early August. In field plants the month of May is the time of most abundant production of dormant apices. Therefore herbarium plant data suggest a somewhat later onset of formation and a later peak production of dormant apices than was observed in the field.

The most active germination period of dormant apices occurs in late September through late October as shown from herbarium plants. Similar observations have been made on field plants which have arisen through germination of dormant apices. These plants are recognizable because the basal stem portion is attached to an axillary portion of a dormant apex, and they occur in greatest abundance from mid-October through the following April.

SEXUAL REPRODUCTIVE CYCLE BASED ON FIELD AND HERBARIUM PLANTS

The inflorescence bears flowers in interrupted spirals in groups of 2–4 florets on terminal spikes. Flowers are bisporangiate, actinomorphic, and hypogynous. The gynoecium consists of four apocarpous, vase-shaped, red-brown carpels, of which 0–4 develop into mature nutlets. Stigmas are peltate at the apex of short styles. The stamens have 2-celled, buff-colored anthers, closely appressed to the carpel wall surrounding the gynoecium. Anther locules are elliptic in longitudinal section, and the anthers dehisce longitudinally. External to the anthers, the bases of which are adnate to the central portion of the anther connective tissue, is a whorl of four red-brown, broadly ovate structures, variously interpreted as outgrowths of the anther connective, perianth parts, or sepaloid connectives (Ogden 1943, Sattler 1965, Singh 1965). Before anthesis, these so-called sepaloid connectives are appressed to the anthers. Following pollination, anthers and sepaloid connectives dehisce,

and carpels develop into nutlets bearing at their distal ends a characteristic beak which is commonly 3/4 the length of the ovary.

A diagrammatic representation shows the sexual life cycle as a function of time of year (Fig. 2). An individual plant is illustrated as it appears at the time of floral bud induction (Fig. 2A). Anthesis begins shortly after exsertion of inflorescences above the water surface (Fig. 2B). Flower buds were first noted in large populations of plants on 16 April 1977 and their production continued through 3 June. The inflorescence is the only portion of the plant ordinarily raised above the water surface. This extension of the inflorescence above the water is made possible by the exaggerated production of air spaces in the upper portion of the stem. After pollination, the inflorescence retracts to below the water surface (Fig. 2C). The time interval from bud induction until the reaction of pollinated flowers comprises approximately 16–18 days within a given population. The stage illustrated in Fig. 2C represents the growth form of the plant as observed in late May and early June. The period of completion of seed set (Fig. 2C) corresponds to the period which dormant apex formation is initiated and completed during late May-early June. As a result, abscission of fruit clusters results from one of two mechanisms. First, since dieback of most parent plants occurs after production of dormant apices and completion of seed set corresponds seasonally to the termination of dormant apex production, "release" of mature adult clusters may result from degradation and decay of all portions of the vegetative plant. This degradative process is the usual state of affairs in the life cycle and apparently the more prevalent mode of fruit release. The only portion of the plant remaining alive after the occurrence of this release is the dormant apices and mature fruit clusters. Second, abscission of the entire seed cluster may occur in plants which persist in the leafy state after maturation of fruits.

Fruit formation in *P. crispus* is essentially restricted to water depths of 3–12 inches (Hunt & Lutz 1959). However, plants have been observed bearing fruits in much deeper water as occurs in the Delaware Wildlife Area ponds, and as much as 185 cm in the harbor at Put-in-Bay, Ottawa County, Ohio. Fruiting may occur only infrequently in depths as shallow as those reported by Hunt and Lutz.

The season during which seed germination occurs is unknown, if seed germination ever does occur in wild populations. At no time during field observations was a germinating seed or seedling of *P. crispus* observed, although germinating seeds and seedlings of *Potamogeton nodosus* Poiret were frequently seen in the same two ponds. Seeds in supposedly mature fruits of *P. crispus* collected from those ponds and placed in aquaria at room temperature remained ungerminated for more than one year. No seedlings were observed on any of the herbarium plants. Muenscher (1936) reported no germination of seeds of *P. crispus* following storage for 2–3 months, 5–6 months, and one year in the dried condition. He did not experiment with germination following wet storage. However, Sauvageau (1894) and Guppy (1897) induced germination following storage for periods of one and two years, respectively.

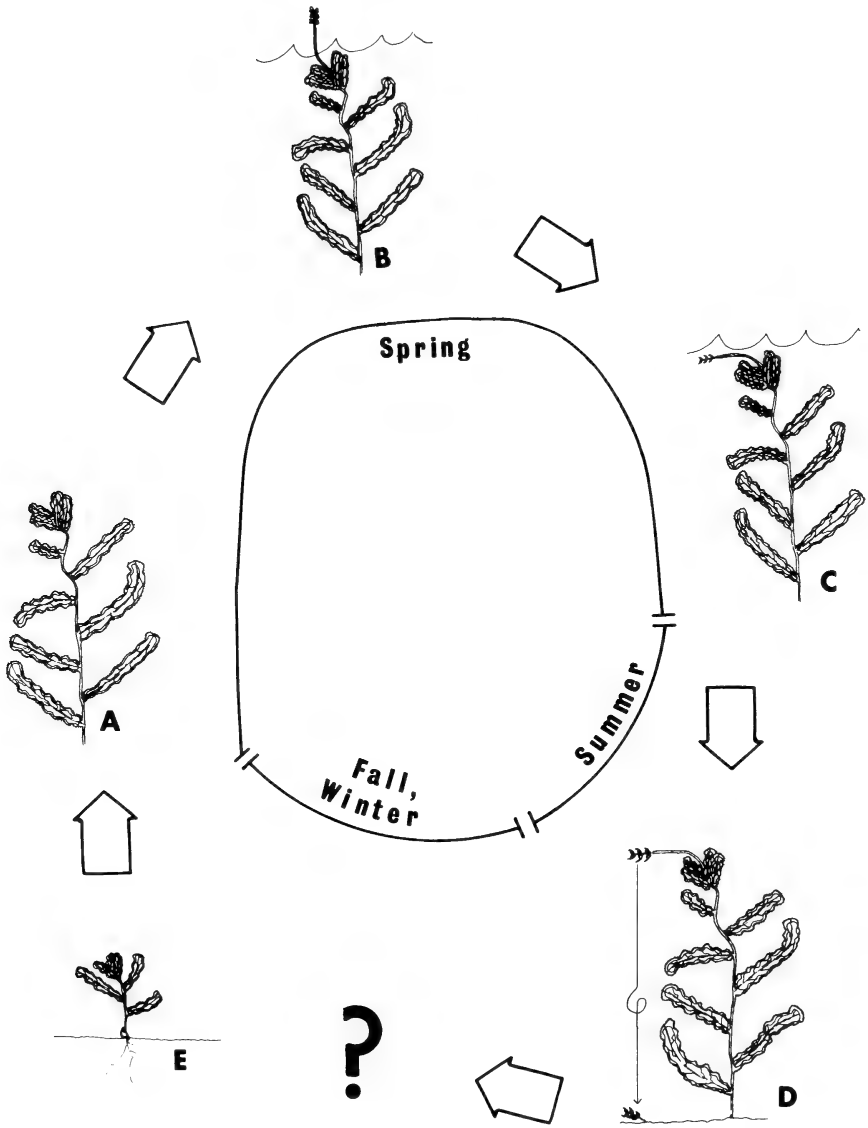

FIGURE 2. The sexual life cycle of *Potamogeton crispus* based on field observations. 2A, plant immediately prior to floral induction; 2B, mature flowering specimen, with inflorescence exserted above water surface; 2C, plant following pollination, with inflorescence stalk retracted to below water surface; 2D, release of mature fruits from parent plant; 2E, germinating seed.

TABLE 3. Number of inflorescences counted per 625 cm^2

Date Sampled	Number of Inflorescences per 625 cm^2
11 May 1977	0.12
15 May 1977	1.24
17 May 1977	1.88
19 May 1977	1.92
24 May 1977	1.08
27 May 1977	0.32
6 June 1977	0.12

The number of inflorescences per unit area was determined during May 1977. Mean density values corresponding to each date sampled were calculated from counts made on 25 random tosses of a 625 cm^2 grid at the water surface. Tosses of the grid were made near the center of a large plant population in Pond 1B (Table 3).

Based on counts of 100 inflorescences, a mean value of 4.67 florets per inflorescence was established. From among 37 inflorescences collected, 130 maturing seeds were counted, giving a mean value of 3.51 per inflorescence. With a peak value of 1.92 inflorescences per 625 cm^2, a mean of 8.97 (i.e., 1.92 x 4.67) florets and 6.74 (1.92 x 3.51) fruits could have been produced per 625 cm^2.

Tagged inflorescences in the two shallow ponds at the Delaware Wildlife Area gave the following mean values for intervals between onset of bud formation, anthesis, and seed set: from bud formation to the bud's rising above the water surface (1.74 days), from the bud's rising to anthesis (1.0 day), from anthesis to anther dehiscence (1.27 days), and from anther dehiscence to seed set (5.7 days).

Data from herbarium plants were tabulated with regard to specific aspects of the sexual cycle. The percentages of specimens bearing flower buds, flowers in early stages of development prior to anther dehiscence, or both situations, and mature fruits were calculated from these dried plants. The highest percentage of young flowers present on specimens was observed for late May. Spring and early summer appear to represent the periods of most abundant flower production. Mid-May also was the period of most abundant flower production as observed in the field plants.

DAY LENGTH IN RELATION TO FORMATION AND GERMINATION OF DORMANT APICES

METHODS

The role of day length in the formation and germination of dormant apices was investigated by placing an aquarium in each of two growth chambers under controlled environmental conditions. The first chamber, illuminated with a combination of incandescent and fluorescent lights of 2100 foot-candles was maintained under short-day conditions of 8 hours light and 16 hours dark at a constant temperature of 25°C. The second chamber was also maintained at a

constant 25°C with an illumination of 2200 foot candles. Day length was maintained under long-day conditions of 16 hours light and 8 hours dark. Intact, leafy, rooted plants, floating, non-rooted plants, and mature, dormant apices were placed in both aquaria.

RESULTS AND DISCUSSION

Dormant apices were formed on the green, leafy, rooted plants under long-day conditions. No dormant apices were formed under short-day conditions, even after four weeks. On the other hand, non-rooted, floating plants formed dormant apices under short-day conditions, beginning 4–5 weeks after initial exposure to these conditions. Approximately 80% of the dormant apices germinated under both short- and long-day conditions, revealing that germination of these structures is not under photoperiodic control. The experimental conditions of long days at 25°C under which intact, leafy, rooted plants form dormant apices correspond to those constraints—warming water temperatures and lengthening days of early spring—under which plants begin formation of dormant apices in the field.

The fact that dormant apex production, under short-day conditions, was induced in non-rooted, but not in rooted, plants accords with the literature which contends that conditions of poor nutrition elicit formation of dormant structures in aquatic vascular plants (Goebel 1900, Gluck 1906, Arber 1920). The absence of roots may place a plant under conditions of nutrient stress. Bristow and Whitcombe (1971) reported that roots were important in the uptake of phosphate by three submersed aquatic species which they investigated. Pond (1905) also reported retarded growth of *Potamogeton perfoliatus* L., *Ranunculus aquatilis* L., *Elodea canadensis* Michaux, and *Myriophyllum spicatum* L. (=*M. exalbescens* Fern.) in the absence of root attachment. This retardation of growth was attributed by Pond to the plants' inability to secure phosphorus and potassium when not rooted.

In addition, the finding that dormant apices tend to form only under long-day conditions supports the contention that dormant apices of *P. crispus* are not functionally winter buds. Weber and Noodén (1976a) reported that *Myriophyllum verticillatum* L., a species which forms true functional winter buds, can be induced to form such buds only under short-day conditions following exposure to long days—those day-length conditions which simulate fall and winter. *Potamogeton crispus*, on the other hand, can be induced to form dormant structures under long-day conditions—those day-length conditions which simulate spring and summer.

Sculthorpe (1967, pp. 354–356) considered the major factors effecting the germination of dormant structures in aquatic plants to be temperature and light intensity. He noted that the dormant structures of species in *Ceratophyllum*, *Elodea*, and *Potamogeton* can be broken as early as November or December if these structures are exposed to "indoor" temperatures. Frank (1965) studied environmental constraints under which winter

buds of *Potamogeton nodosus* can be caused to germinate. Removal of the bud scale of the winter buds in the presence of light was shown to increase germination. A cold treatment consisting of three days of 0°C decreased the period required for after-ripening of buds. Dormancy was lost through aging of buds. Exposure to high temperatures resulted in breaking the dormancy of a high percentage of buds tested.

The turions (overwintering buds) of *Wolfiella* can be induced to germinate in response to similar treatment involving two weeks at 25°C or above (Pieterse et al. 1970). Germination of turions of *Myriophyllum verticillatum* has been induced in response to long days (16 hours) but not short days (8 hours) and in response to short days following a cold treatment (Weber & Noodén 1976b).

Factors controlling the germination of dormant apices in *P. crispus* investigated by Waisel (1971) revealed nearly 100% germination as a result of 14-day cold treatments of 10°C and approximately 30% at 20°C also for 14 days. Partial desiccation of dormant apices decreased germination rates by about 50% at 10°C and 20°C. Following freezing of dormant apices (-10°C) increased their germination rate at 20°C.

Waisel's report of an increased germination rate of dormant apices following freezing has not been repeated. Attempts at exposing dormant apices to freezing temperatures resulted in quick degradation and decay of all species following thawing. However, exposure to a cold treatment does appear necessary for germination of newly matured dormant apices. Groups of 30 newly-formed dormant apices per treatment were each maintained under constant illumination at 7.5°C for 1, 5, 16, 22, and 41 days. After each cold period, the apices were placed at a constant temperature of 25°C under 16-hour daily illumination until 41 days elapsed from the initial exposure to cold conditions. At that time, germination percentages for each group were determined. For the 0, 1, 5, 16, 22, and 41-day exposures, germination rates were 13%, 60%, 53%, 93%, 83%, and 87%, respectively. The high germination rates of over 60% following cold treatments of one day or more indicate the necessity for such exposure. This finding corresponds to seasonal behavior observed in the field. Germination of dormant apices generally begins in September, as water temperature begins to decrease.

More recent experimental and field studies of the formation and germination of the turion show similar results. Rogers and Breen (1980) reported that some turions may germinate soon after they are formed, but most enter a period of dormancy which lasts through the summer months when temperatures are above 25°C and germinate in autumn months when water temperatures drop below 25°C. Kadono (1982) and Sastroutomo (1981) both noted that turions formed during May-June remained dormant during the summer months, and germinated under cooler temperatures in the late autumn.

ROLE OF DORMANT APICES AND FRUITS

The terms winter bud, turion, and hibernaculum have been used synonymously with the dormant apices produced by *P. crispus* (Arber 1920, p. 68; Muenscher 1944, pp. 30, 41; Fernald 1950, p. 71; Correll & Correll 1972, p. 101). The use of winter bud is misleading for several reasons. These three terms are in reality misnomers because they carry the implication that the structures allow the plant to overwinter in the dormant state, as is the case with the true winter buds of species in *Utricularia*. As has been discussed, the dormant apices of *P. crispus* are formed in late spring and early summer and allow the plant to persist for the remainder of the summer in the dormant state. Germination occurs in the fall, and the plant overwinters in the form of young leafy plants, not dormant apices. The term winter bud is also misleading in that the dormant structures contain several dormant buds (usually 5–7) instead of just one. The term is ambiguous in that it denotes a resting bud which allows a plant to pass the winter in a dormant state, yet the term also may be used simply as a descriptive morphological term, without the realization that it also has a functional mission.

Much speculation has appeared in the literature regarding the relative contribution of fruits vs. dormant apices to the propagation of *P. crispus* (Yeo 1966). Dormant apices are the chief propagative structures in this species according to Gluck (1906, p. 157), Moore (1915), and Arber (1920, p. 69). In 100 plants selected at random, Moore (1915) reported the production of 266 dormant apices and 32 floral spikes. Although the rate of production of flowers and fruits is certainly greater than other authors suggest, several factors suggest that vegetative propagation by dormant apices is by far the more productive means. Muenscher (1936) noted difficulties in inducing germination of seeds of *P. crispus*, and germinating seeds were never observed during our study. The production of dormant apices is abundant and rapid, their germination is easily induced in the laboratory, and individual plants which have grown from dormant apices are abundant in field populations.

Further speculation has arisen concerning the biological role of the dormant apex—simple propagation, dispersal, or overwintering. Certainly all three roles are carried out to a degree, but the structure's value in propagation and dispersal certainly outweighs the value of any occasional overwintering. Concurrence in this opinion is expressed by Gluck (1906, pp. 157-158), Moore (1915), and Arber (1920, p. 69). Gluck (1906) pointed to the superfluity of dependence on such a structure for overwintering, when the entire plant overwinters in the green, leafy condition on a regular basis.

SUMMARY

The life cycle of *Potamogeton crispus* has three plant growth forms: undulate, serrulate-margined spring foliage; modified stem tips called dormant apices; and flat, entire-margined winter foliage. In the form of leafy, green plants bearing the foliage of winter morphology the plants can persist in water with an ice cover of 20 inches, a snow cover of 5 or more inches, and incidental light intensities of 140 foot-candles or less. The dormant season occurs during the

summer. During this period, if water temperature increases sufficiently in conjunction with increasing day length, stems will form dormant apices which remain in the resting state throughout the summer and germinate in the autumn. The plants exhibit little phenotypic plasticity within a given season, but a great deal of variability, particularly in leaf morphology, is exhibited from one season to another. Such variability may account for the several named plant varieties that have been needlessly proposed. Data from plants studied in the field correlate well with the herbarium plants from a broad geographic range, in similar seasonal comparisons of leaf margin, leaf length, dormant apices, flowering, and fruiting. Field observations regarding alternation in leaf width did not correlate well with herbarium data. Flower production appears to reach a peak in mid-May. Seed production in the field populations occurs in greater abundance and at greater depths than has been suggested in the literature. If in fact the seeds do germinate in wild populations, the season for their germination is unknown. With regard to the increase in number of individuals, the dormant apices appear to be of greater significance than do the seeds. This statement is based upon the known abundant production of the dormant apices and upon their ability to germinate, in contrast to the difficulty of inducing germination in seeds and not locating any germinating seeds in the field. Formation of the dormant apices appears to be under photoperiodic control, at 16-hour day-lengths at 25°C. Germination of dormant apices seems to be dependent on exposure to a prior non-freezing cold treatment.

ACKNOWLEDGMENTS BY JOHN WEHRMEISTER

I thank Prof. Ronald L. Stuckey of The Ohio State University for advice during the study and for preparing the manuscript for publication. I am grateful to Dr. Robert Platt, Kathran Chan, Edward Toth, William Carr, Robert Bartolotta, and Patricia Dalton, who accompanied me on trips to conduct wintertime field work. I thank Margaret A. Ross for translation of two French articles and to Dale A. Haney for permission to conduct research at the Delaware Wildlife Area. My thanks is extended also to the curators of the following herbaria (abbreviations from Holmgren et al. 1981): BKL, CAS, DS, ISC, MICH, NA, OS, PH, SD, and WIS.

ACKNOWLEDGMENTS BY RONALD L. STUCKEY

My thanks are extended to my students who have assisted me in the production of the manuscript for publication: J. Perry Edwards, Tracy L. Engle, and John F. Frederick.

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ANNOUNCEMENT
RONALD L. STUCKEY INITIATES ENDOWMENT FUND FOR THE OHIO STATE UNIVERSITY HERBARIUM

Ronald L. Stuckey, Professor of Botany at The Ohio State University, presented a gift of $30,000 to the University's Foundation to initiate an endowment for the support of the University Herbarium. The presentation was made as a final surprise announcement at Professor Stuckey's retirement party celebrating 26 years of teaching at the University. The event, held on 21 September 1991 at the University Ramada Hotel, Olentangy River Road, Columbus, was attended by 130 colleagues, former students, relatives, and close friends. They came from the central Ohio area, elsewhere in the state, and eight other states.

Designated as the Ronald L. Stuckey Herbarium Fund, Dr. Tod F. Stuessy, director of the University Herbarium, stated that the endowment was a "wonderful gift" that will aid in the studies of the flora of Ohio, which are of particular concern to the donor. Director Stuessy also praised Prof. Stuckey for his dedication, thoughtfulness, and genuine care for the future development of the Herbarium.

The establishment of the endowment fund for the University Herbarium not only marks the occasion of Dr. Stuckey's retirement from teaching, but also commemorates the 100th anniversary of the Herbarium. The fund creates a foundation for its future as a part of the Biological Sciences' new Museum of Biological Diversity.

The Ohio State University Herbarium was founded in 1891 by the University's first Professor of Botany, Dr. William A. Kellerman. Initially the Herbarium was housed in Botanical Hall (site of the present-day Faculty Club Building) and moved in 1914 to the Botany and Zoology (B&Z Building), 1735 Neil Avenue. The Herbarium will soon be relocated to the former food facility building (1315 Kinnear Road) now being renovated to house all of the biological collections of the University. Prof. Stuckey served as curator from 1967 through 1976.

—Ronald L. Stuckey

ANNOUNCEMENT
A New Book
WOMEN BOTANISTS OF OHIO. By RONALD L. STUCKEY

This volume describes the contributions of 18 women active in Ohio Botany who were born before 1900. Thirty-seven photographs and a roster of 90 Ohio women botanists are included in the 78 pages.

To order, send a check or money order payable to the author for $11.50 to: Dr. Ronald L. Stuckey, R L S Creations, P.O. Box 3010, Columbus, OH 43210.

A review of this publication is now being prepared and will appear in a forthcoming number.

ANNOUNCEMENT
The Ohio State University Herbarium
PUBLIC LECTURE AND WORKSHOP SERIES
Celebrating 100 Years of The Ohio State University Herbarium

LECTURES

May 5 **Progress Toward an Automated Plant Information System for Franklin County.** Richard M. Lowden, Visiting Associate Professor of Plant Biology and John J. Furlow, Supervisor, The OSU Herbarium

June 2 **The History of the Ohio State University Herbarium.** Ronald L. Stuckey, Curator Emeritus, The OSU Herbarium.

WORKSHOPS

May 16 **An Aquatic Plants Workshop: How to Know the Aquatic Plants of Central Ohio.** Ronald L. Stuckey, Curator Emeritus of The OSU Herbarium.

June 13 **A Compositae Workshop: The Sunflowers, Daisies, and Thistles.** Tod F. Stuessy, Director, The OSU Herbarium.

The lectures will each begin at 8:00 P.M. in Room 208, Botany and Zoology Building, with refreshments served afterwards in the Herbarium, Rm. 312. The workshops will meet in the Herbarium, Rm. 312, Botany and Zoology Building, from 8:00 A.M. to 12:00 Noon.

All programs are open to everyone and free of charge. However the size of the field trip and workshop groups must be limited, so if you want to take part in one of these, **you must first reserve a place.** Please call the Herbarium (292-3296) any time prior to the date of the program you would like to attend, and we will add you to our list or be glad to answer any questions you might have.

Parking is available in the 12th Avenue Garage, located just west of the B & Z Building. (Note that a traffic gate blocks 12th Avenue near the B & Z Building, so this garage must be entered from the west, via Cannon Drive and 12th Avenue, not from the east past the B & Z Building itself.)

For further information, call Dr. John Furlow at (614) 292-3296.

ANNOUNCEMENT
FIELD BOTANISTS OF ONTARIO FIELD TRIPS

The Field Botanists of Ontario have released their schedule of field outings for 1992. Twelve trips are planned, including eight between 1 June and 31 August. All trips require advance registration and attendees that are not FBO members are charged $5.00 above the members' cost. Persons interested in obtaining additional information about these trips should contact: Bill Draper, 48 Brunswick Avenue, Toronto, Ontario, M5S 2L7, CANADA.

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THE DEVELOPMENT OF GEMMAE AND PLANTLETS ON LEAVES AND LOBULES OF FRULLANIA EBORACENSIS GOTTSCHE (HEPATICAE)

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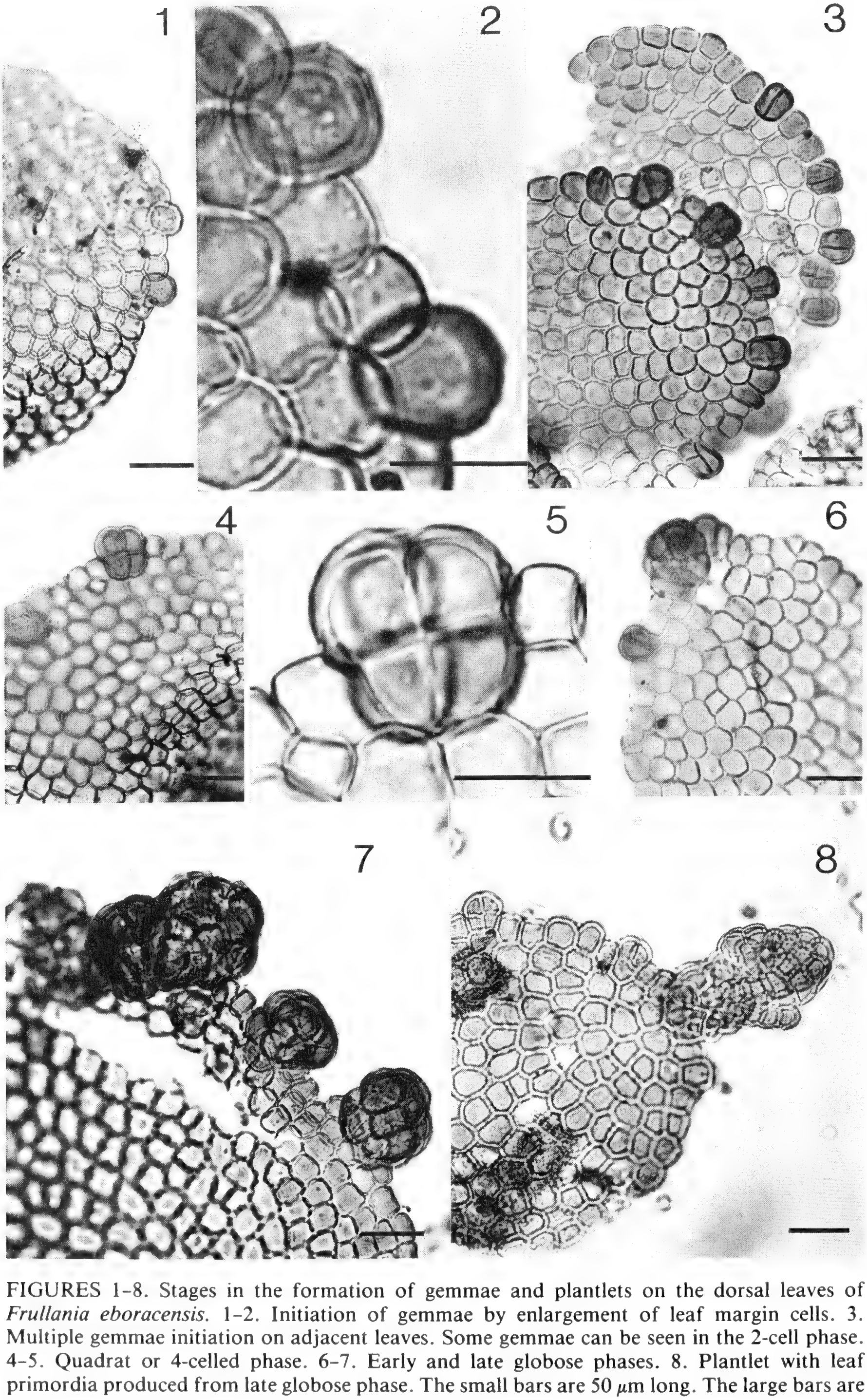
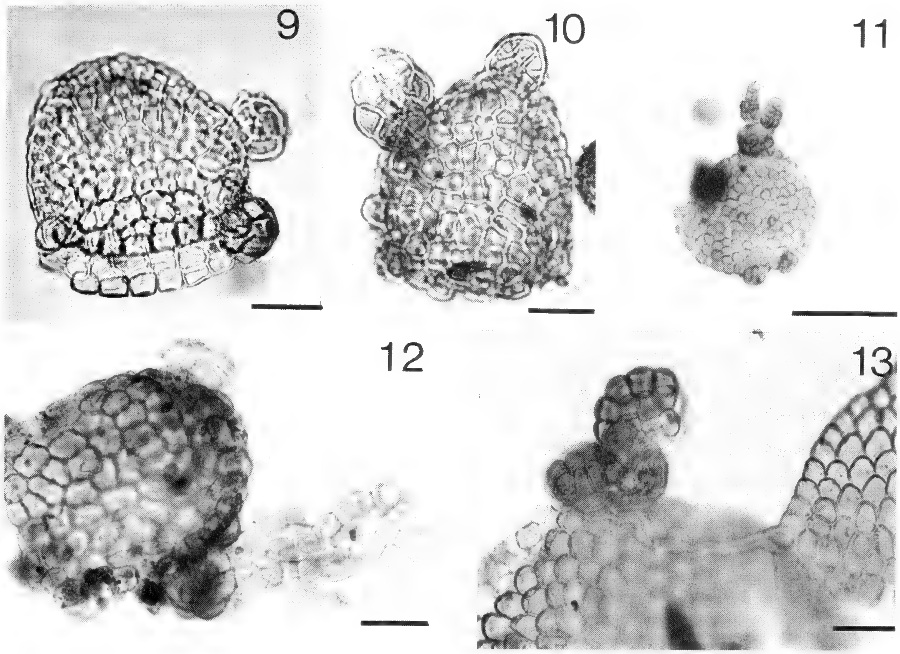
While studying the genus *Frullania* in Michigan (Ehrle 1991), 323 Michigan collections of *F. eboracensis* were examined. Of these, 61 (18.9%) contained plants exhibiting various stages of gemmae and plantlet formation. Separating colonies into individual plants would likely have revealed additional gemmae-bearing plants. It is estimated that at least 25% of the Michigan material is gemmiferous. The identification of the gemmiferous plants was confirmed; they were mounted in Hoyer's solution and photographed using 35mm Kodak Plus-X film.

Given the frequency of gemmae and gemmae-derived plantlets in Michigan material, it is surprising that so little is said of them in the literature. Evans' (1897) revision of the American species of *Frullania* made no mention in keys or descriptions of gemmae in *F. eboracensis.* Cavers' (1903) and Kreh's (1909) review of asexual reproduction and regeneration in the Hepaticae discussed *F. fragilifolia* and *F. dilatata,* both of which are European, but made no reference to *F. eboracensis.* Stevens' (1910) description of discoid gemmae in the leafy Hepaticae of New England provided information on several genera but made no mention of *Frullania.*

There is some uncertainty as to the most appropriate terminology for the asexual reproductive structures formed by *Frullania eboracensis.* Some bryologists might prefer the more general terms regenerant, diaspore, broodbody, or propagulum. The last seems inappropriate since a propagulum is defined as a "reduced bud, branch or leaf serving in vegetative reproduction" in the *Glossarium Polyglottum Bryologiae* (Magill 1990). It might be more accurate to refer to them as gemmae or cladia. The latter are defined as "modified regenerant branches that arise from normal shoots, or thalli and detach readily for vegetative reproduction." This, too, seems inappropriate since the structures involved are not modified regenerant branches. Having watched their development from single gemmae-like cells, I prefer to refer to the products as plantlets and the cells from which they arise as gemmae. Although there is no technical problem with designating the early stages as gemmae, structures so-designated are most commonly thought of as being released from the parent plant in an undeveloped state to pursue development elsewhere. That, indeed, may be the fate of most of the units, at least in their early stages of development. There are clearly many more gemmae present on leaves than there are plantlets. Since most of these units



FIGURES 1–8. Stages in the formation of gemmae and plantlets on the dorsal leaves of *Frullania eboracensis*. 1–2. Initiation of gemmae by enlargement of leaf margin cells. 3. Multiple gemmae initiation on adjacent leaves. Some gemmae can be seen in the 2-cell phase. 4–5. Quadrat or 4-celled phase. 6–7. Early and late globose phases. 8. Plantlet with leaf primordia produced from late globose phase. The small bars are 50 μm long. The large bars are 20 μm long.



FIGURES 9–13. Stages in the formation of gemmae and plantlets on the ventral lobules of *Frullania eboracensis*. 9–10. Early and late globose phases. 11–12. Plantlet formation from late globose phase. 13. Rhizoid formation. The small bars are 50 μm long. The large bar is 200 μm long.

have been shed and have developed elsewhere, they should be called gemmae, even though some of them remain attached and develop *in situ*.

Lorenz (1912) provided the first description and illustrations of the gemmae and gemmae-derived plantlets produced by *Frullania eboracensis*. Her descriptions and figures are accurate and compare well with the features of the Michigan material described herein. She described the caducous leaves, as well as gemmae and plantlets in both dorsal leaves and ventral lobules. Degenkolbe's (1937) review of "Brutorgane" in leafy liverworts included information on ten species of *Frullania* but made no mention of *F. eboracensis*; nor is the Lorenz (1912) paper cited even though others from the *Bulletin of the Torrey Botanical Club* for 1910, 1911, and 1935 are cited.

Frye and Clark (1937–1947) included a one-sentence reference to "gemmae on margins of leaves" in their description of *F. eboracensis*, but there is no mention of them in Steere (1940) or Schuster (1953). Fulford's (1956) paper on *F. asagrayana* provided a brief summary of Lorenz's (1912) description. This description is repeated, augmented, and illustrated with line drawings by Hicks (1974). Crum (1991) indicated that globose gemmae are sometimes formed on leaf margins and that these may proliferate leaf primordia while still attached.

Thus, in nearly 100 years of work, descriptions of gemmae formation in *Frullania eboracensis* are provided only by Lorenz (1912), Hicks (1974), and Crum (1991). This is even more surprising since these structures likely play a vital role in the reproductive biology of the species. The environment in which *F. eboracensis* grows is quite harsh. It occurs on the trunks of trees where periodic dessication is likely and where spores produced by normal sexual processes are likely to be blown away into unsuitable habitats. As Hicks (1974) pointed out, the gemmae are easily detached but are not found lying about on the plants that produced them "which leads one to believe they are detached by water." The trunk of a tree serves as a conduit along which rain water gathered by the crown of the tree is passed to the ground. This passage would not only break off gemmae and plantlets but also wash them into bark fissures where they are more likely to continue development. Among the eight species of *Frullania* in Michigan, only *F. eboracensis* produces these structures with any regularity. They are absent or quite rare in the other species. This may well be the reason why *F. eboracensis* is the most frequently encountered *Frullania* in Michigan and throughout its range.

The earliest discernible stage in the formation of gemmae in *F. eboracensis* involves the enlargement and increased pigmentation of single cells (Figs. 1 & 2), usually on the margins of dorsal leaf lobes. These cells divide at right angles to the leaf margins (Fig. 3) and then parallel with the margins to form a 4-celled stage (Figs. 4 & 5). These early stages are fairly easy to recognize, even at low magnification, due to their increased pigmentation, thickened cell walls, and projection beyond the leaf margin. Subsequent division produces a globose stage (Figs. 6 & 7) containing an apical cell which gives rise to a plantlet (Fig. 8). Gemmae may also arise from any portion of ventral lobules (Figs. 9–12) but are most frequently seen near the mouth or at the top of the lobule. Numerous plants bear gemmae and plantlets on the dorsal leaves and ventral lobules simultaneously. Occasionally, rhizoids are formed on the margins of leaves (Fig. 13) as well as gemmae and plantlets.

Hicks' (1974) study based on several specimens from northwestern North Carolina indicated that gemmae were not seen on ventral lobules. She also commented on the absence of "small shoots that developed *in situ* from gemmae." Perhaps, as additional material is examined form northwestern North Carolina, both of these features will be observed. Alternatively, climatic differences between North Carolina and Michigan may have resulted in different expressions of the gemmae-forming potential of these plants.

The material studied by Hicks (1974) from the southern Appalachian Mountains was collected in June, July, September, and October. She reported that "other collections in the same area lacked gemmae, which may be an indication that initiation of gemma formation was controlled by individual internal regulators or by microclimatic factors." Gemmae production in Michigan seems to occur throughout the year except for January, February, and March. Of the 61 gemmiferous collections examined, 31 were collected by the author during September and October. The other 30 collections were distributed, by month, as follows: April (7), May (6), June (1),

July (6), August (2), September (3), October (2), November (2), and December (1). This distribution may be more related to the field habits of bryologists than to any regulatory mechanism causing the onset of gemmae formation.

The Michigan collections from which the photographs were taken are listed below.

Fig 1, 2.	JACKSON CO.: E. of Napoleon, *Jaworski 1600* (MICH).
Fig. 3, 6, 8, 12.	TUSCOLA CO.: Caro, *Wetmore 1061* (MSC)
Fig. 4, 5, 7.	BARAGA CO.: Silver River Falls, *Hermann 23153* (MICH).
Fig. 9, 10.	LEELANAU CO.: N. Manitou Island, 4 Aug 1957, *A. J. Sharp s.n.* (MICH).
Fig. 11, 13.	OAKLAND CO.: Highland Recreation Area, May 1973, *H. Crum s.n.* (MICH).

ACKNOWLEDGMENTS

Appreciation is expressed to Western Michigan University for granting the sabbatical leave which made this and other work possible and to W. R. Anderson, Director of the Herbarium at The University of Michigan, for arranging space to work and access to the herbarium collections and library. Thanks are also due to the following curators and institutions for the loan of specimens: R. Hollensen, Michigan State University; J. Glime, Michigan Technological University; M. Bowers, Northern Michigan University; and R. Vande Kopple, University of Michigan Biological Station. Special thanks are given to Dr. Howard Crum, The University of Michigan, for his friendly encouragement, advice, and suggestions for improvement of the manuscript.

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ANNOUNCEMENT
UNIVERSITY OF MICHIGAN HERBARIUM ESTABLISHES ENDOWED FUND FOR STUDENT RESEARCH SUPPORT

Faculty, alumni, and friends of the University of Michigan Herbarium have joined to create an endowment called the Herbarium Student Fund. As of 3 November 1991 the gifts, ranging in size from $50 to $1000, amounted to a total of $16,400. Income from the endowment will be used to support the research of undergraduate and graduate students working with curators and research scientists in the Herbarium.

The need for such a fund was described in the following way by the Herbarium's Director, William R. Anderson, in his invitation to others to help in the effort to establish the Fund:

> The University of Michigan Herbarium has long been an important center for training students in the systematics of plants and fungi. As more and more universities deemphasize systematics, our Herbarium becomes ever more essential as a source of people who have broad training in biology as well as excellent credentials in some aspect of plant systematics. If we are going to continue to fill that niche we need to be able to help our students meet the expenses associated with their research. That has always been difficult, but in recent years the difficulty has increased because, in addition to traditional expenses such as field work, travel to other herbaria, photography, and anatomical work, today's students often need to buy the expensive enzymes and other supplies needed for molecular systematics. In five years as director of the Herbarium I have felt frequent frustration at my inability to give our students all the help they need and deserve as they struggle to do good modern systematic research. One way to address this need would be to establish an endowed fund in the Herbarium, the income from which would be devoted solely to assisting our students with their research expenses. . . . A small and shrinking group of systematists are at the base of all efforts to describe and understand the earth's "biodiversity." I hope we'll be here in increasing numbers as *Homo sapiens* tries to come to terms with the other species with which we share the planet.

Apparently many others around the country share those concerns about the training of systematists, because the response was swift and generous. Recent students were especially warm in their praise of the idea, only regretting that such aid had not been available during their tenure at Michigan.

Endowment funds are established in perpetuity; the principal can never be spent, and the University protects it against inflation by reinvesting a part of the income. As established, the Fund will produce over $900 per year, which can be used to cover travel, supplies, equipment, and living expenses, but not tuition. The principal of endowment funds can be augmented at any time, and Dr. Anderson hopes that additional gifts from friends of the Herbarium will build the Student Fund to a goal of $50,000 over the next few years. He encourages potential donors with questions to call him at (313) 764-2432, and to send him their checks for any amount, payable to "University of Michigan Herbarium," with a note stipulating that their gift is intended for the Herbarium Student Fund. His address: William R. Anderson, University of Michigan Herbarium, North University Building, Ann Arbor, MI 48109-1057.

INITIAL OBSERVATIONS ON TEGUMEN LAYER VARIATION IN THREE SPECIES OF LUZULA (JUNCACEAE)

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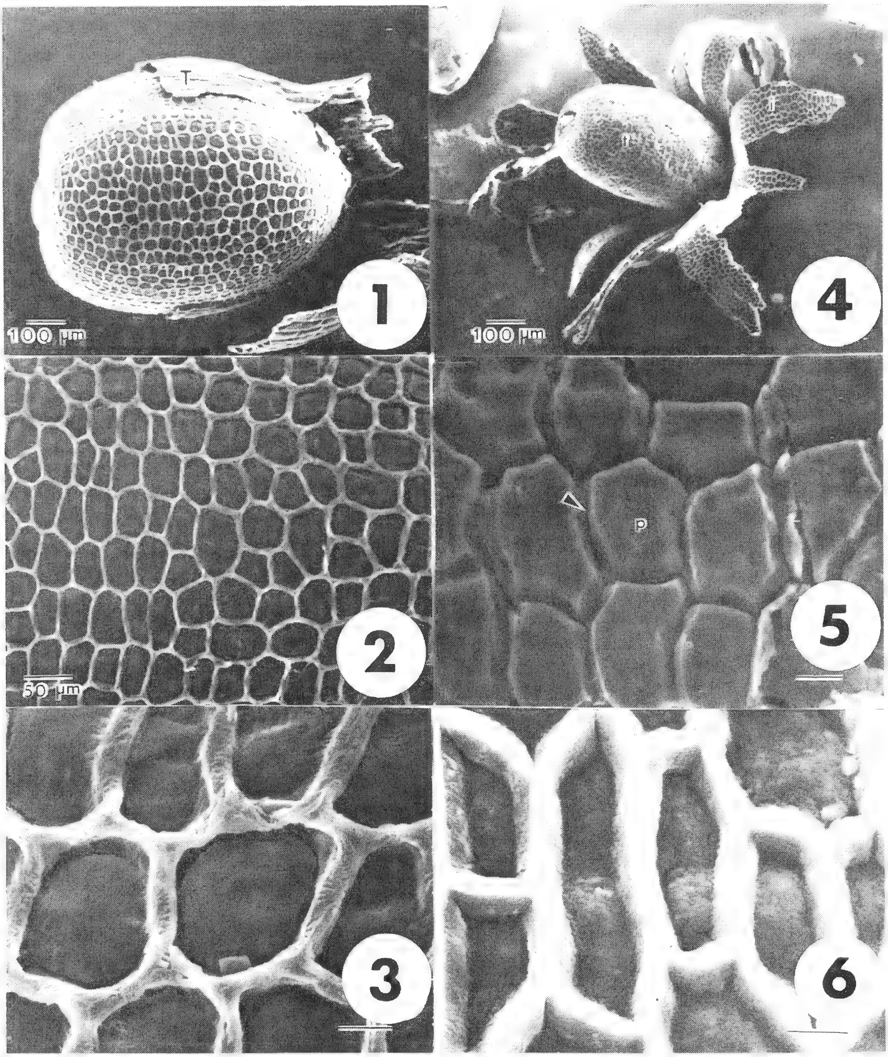
Taxa of *Luzula* DC. are easy to identify, using characters of leaf pubescence, inflorescence type, capsule and perianth length, and seed appendages (Voss 1972). *Luzula* subgenera are less well defined, with often overlapping characters of inflorescence type, leaf apex shape, and seed apex and base shapes (Buchenau 1906). The recognition of additional characteristics may better elucidate inter- and intraspecific relationships as well as generic relationships with *Juncus* and other genera within the Juncaceae. Because they are generally regarded as significant taxonomic characters within the Angiosperms (Echlin 1968, Heywood 1969, Stuessy 1979, Lane 1985), the micromorphological features of leaves, fruits, and seeds provide an additional source of characters. Although there have been five studies establishing the micromorphological characteristics of the seed tegumen layer of the taxa of *Juncus* Tourn. (Clemants 1979, Brooks & Kuhn 1986, Ertter 1986, Catling & Spicer 1988, Zech & Wujek 1990), no work using scanning electron microscopy (SEM) has been published for the genus *Luzula*. First examined by light microscopy and described in 1867 by Buchenau and later by Vierhapper (1930) and Satake (1933), the original data generated from *Luzula* seed configurations lacked the resolution afforded by SEM.

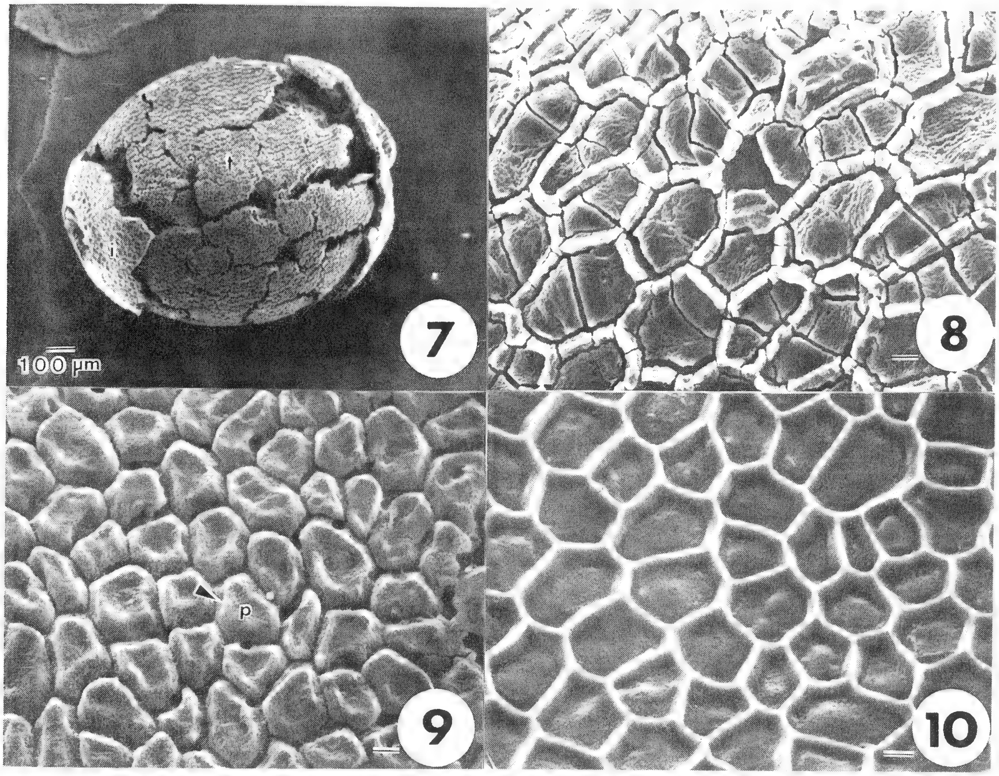
The seeds of *Luzula* are composed of outer integument layers and an inner tegumen layer. It is the tegumen layer that consistently exhibits taxonomically significant characters (Clemants 1979). Tegumen configurations have proved taxonomically significant within *Juncus* (Clemants 1979, Brooks & Kuhn 1986, Ertter 1986, Zech 1986, Catling & Spicer 1988, Zech & Wujek 1990). The objective of our study was to examine by SEM the tegumen layer of the three Michigan species of *Luzula*, representing three different subgenera, and establish if there are any taxonomically significant characters that might aid in predicting phylogenetic relationships within the genus and between other genera within the Juncaceae.

MATERIALS AND METHODS

Using the three regions recognized by the Michigan Department of Natural Resources (the Upper Peninsula, and the northern and southern portions of the Lower Peninsula), we sampled two specimens from each region for two species (see Appendix). The third species does not occur within all three regions, so specimens were sampled from other states and/or provinces. Seeds were collected from mature capsules of a single plant. A minimum of three seeds from each collection were observed, establishing a base number of eighteen seeds examined per species. All *Luzula* seeds were obtained from herbarium sheets at the University of Michigan Herbarium, Ann Arbor (see Appendix).



FIGURES 1–6. Scanning electron photomicrographs of *Luzula* seeds. Each species is shown with the outer membranous coat removed and a portion of the seed coat. Scale represents 10 µm unless otherwise noted. Figs. 1–3. *Luzula multiflora*. 1. Overview of seed's reticulate-foveate tegumen configuration showing a portion of the testa (T) still attached. 2. Reticulate-foveate tegumen configuration of seed. 3. Reticulate-foveate tegumen configuration of seed. Figs. 4–6. *Luzula parviflora*. 4. Overview of seed's tegumen configuration (t) with an outer integument layer (i) still attached. 5. Negative imprint tegumen configuration of seed showing channels that surround plateaus (p). 6. The underside of the upper integument layer (Fig. 4-i) that imprints the negative tegumen configuration of Fig. 5.



FIGURES 7–10. Scanning electron photomicrographs of *Luzula acuminata* var. *acuminata* seeds, shown with the outer membranous coat removed and a portion of the seed coat. Scale represents 10 μm unless otherwise noted. 7. Overview of seed's preparation-damaged tegumen configuration (t) with an outer integument layer (i) still intact. 8. Reticulate-foveate tegumen configuration. 9. Negative tegumen configuration of seed showing channels that surround plateaus (p). 10. The underside of the upper integument layer (Fig. 7-i) that imprints the negative tegumen configuration of Fig. 9.

The seeds were suspended in a 1:9 mixture of sulfuric acid and acetic anhydride and then sonified (Heat Systems-Ultrasonics, Inc. Sonifer) for 5 minutes. After sonification the seeds were left to soak (a minimum of 24 hours) in the acid bath until the outer testa was visibly removed. The seeds were then removed from the acid bath and air-dried on filter paper for 24 hours. Seeds were mounted on aluminum stubs using Tube Koat and copper tape and coated with 30 nm of gold using a Technics Hummer I sputter coater. Observations were made using an AMR-1200 scanning electron microscope. Terminology describing the tegumen configurations was applied, when possible, from Murley (1951).

RESULTS

The three species exhibit distinct tegumen configurations (Figs. 1–10). *Luzula multiflora* (Retz.) Lej. (Figs. 1–3) shows a reticulate-foveate tegu-

men configuration. *Luzula parviflora* (Ehrh.) Desv. (Figs. 4–6) displays a plateau pattern that is the result of an imprint (Fig. 5) from the underside of the reticulate integument layer above (Fig. 6). The tegumen layer consists of channels surrounding plateaus (Fig. 5) and represents the negative of the reticulate integument configuration above (Fig. 6). In contrast to the uniformity of these two species, *L. acuminata* Raf. (Figs. 7–10) showed a reticulate-foveate tegumen configuration (Fig. 8) similar to *L. multiflora* in three of the six samples and a negative configuration (Fig. 9) similar to *L. parviflora* in the remaining three samples. Reexamination of the herbarium sheets verified all as *L. acuminata* var. *acuminata*.

DISCUSSION

Distinct tegumen configurations occur within *Luzula* and the potential exists for them to be taxonomically useful. The intraspecific variation seen within *L. acuminata* var. *acuminata* may represent two different cell layers. Additional study is needed to determine whether the plateaus and reticulae observed are distinct cell layers or possibly an artifact of methodology. For the species of *Juncus* studied to date (Clemants 1979, Brooks & Kuhn 1986, Ertter 1986, Zech 1986, Catling & Spicer 1988, Zech & Wujek 1990), there does not exist a tegumen configuration identical to those found in *Luzula*. While Brooks and Kuhn's (1986; Fig. 19) tegumen configuration for *J. effusus* resembles the configuration of *L. multiflora*, the reticulae of *L. multiflora* as a whole are less angled. The *J. effusus* tegumen configuration studied by Zech (1986) and Zech and Wujek (1990) consistently showed reticulae which were scrobiculate (i.e. elongated) in nature and distinctly different from any of the *Luzula* patterns. Therefore, the character of tegumen configuration may prove helpful in further differentiating between *Juncus* and *Luzula*. Within Juncaceae, Cutler (1969) stated that, based on his anatomical data, *Luzula* was most closely related to *Juncus* subgenus *Poiophylli*. The reticulate-scrobiculate or secondarily ornamented reticulate tegumen configurations established for the taxa of the *Poiophylli* within Michigan (Zech & Wujek 1990; Figs. 23–30), would not support this alliance.

This initial study has established the taxonomic potential of the character of tegumen configuration for taxa of *Luzula*. By no means should this study be considered the final answer. Future studies which employ more extensive sampling of *Luzula* are needed in order to determine more definitive relationships and which levels of the hierarchy (genus, subgenus, and species) this character can be best applied to.

ACKNOWLEDGMENTS

This paper is based on a master's thesis completed at Central Michigan University by the senior author. We thank Dr. A. A. Reznicek for his herbarium assistance and all reviewers for their helpful comments.

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APPENDIX: Voucher Information[a,b]

Subgenus: *Pterodes* Griseb., *Luzula acuminata* Raf. var. *acuminata*: MICHIGAN: Mackinac Co., *Voss 15462*; Chippewa Co., *Voss 1369*; Midland Co., *Dreisbach 5727*; Oscoda Co., *Voss 14593**; Shiawassee Co., *Hicks s.n.*; Ingham Co., *Parmelee 484**.

Subgenus: *Luzula, Luzula multiflora* (Retz.) Lej.: MICHIGAN: St. Clair Co., *Dodge s.n.*; Washtenaw Co., *Merron s.n.*; Emmet Co., *Voss 15401*; [Gratiot Co.?], *Davis s.n.*; Dickinson Co., *Voss 8716*; Keweenaw Co., *Shelton 284**.

Subgenus: *Anthelaea* Griseb., *Luzula parviflora* (Ehrh.) Desv.: ALASKA: McKinley National Park, *Mexia 2229*. ARIZONA: Mt. Humphreys, *Rusby 844**. MICHIGAN: Keweenaw Co., *McFarlin 2110*. WASHINGTON: Clallam Co., *Voss 12967**. CANADA: Lac Monroe, Quebec, *Rolland-Germain 375*; Algoma District, Ontario, *Garton 14499*.

[a]Collections marked with an asterisk are those from which figures 1–10 were made.
[b]All vouchers are deposited at MICH.

PUBLICATIONS OF INTEREST

HALIBURTON FLORA. An annotated list of the vascular plants of the county of Haliburton, Ontario. Eleanor G. and Emerson W. Skelton. 142 pages. Publication Services, Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario, Canada M5S 2C6. Canadian $12.95. An extensively annotated list of the vascular flora of one of Canada's favorite vacation areas, adjacent to and including part of Algonquin Provincial Park, north of Toronto. The authors and others have thoroughly botanized 22 of the county's 23 townships; Eyre Township "was inaccessible to us for collecting purposes." One map shows the township as quite roadless; perhaps that's the reason it was inaccessible. The work is obviously a labor of love and solid scholarship, with careful statements about sources of information, herbaria of deposit, and the like. Very useful maps, including one of postglacial topography; no keys, no nomenclatural innovations; brief bibliography; full indexes to common names and to Latin names.

BOTANICAL EXPLORATION OF THE CANADIAN WATERSHED OF LAKE HURON DURING THE NINETEENTH CENTURY. James S. Pringle. Canadian Horticultural History 2 (1 & 2): 4–88. 1989. Center for Canadian Historical Horticultural Studies, P.O. Box 399, Hamilton, Ontario, Canada L8N 3H8. $7.00 Canadian. A gem of historical scholarship, replete with photographs, detailed history, extensive appendix, and literature citations; with a valuable added attraction, a comprehensive index to all the people (well over 200) mentioned in the text. Devotees of botanical history will want to inquire at the address above about subscribing to this periodical; the four previous issues (comprising volume one, $22.00 US) contain numerous contributions by Pringle and others, including both technical botany as well as gardening.

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A UNIQUE OLD-GROWTH MICHIGAN HARDWOOD STAND WITH SASSAFRAS AS A MAJOR COMPONENT

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INTRODUCTION

The range of sassafras (*Sassafras albidum* (Nutt.) Nees) extends across the eastern United States, in the north reaching the eastern shores of Lake Michigan (Fowells 1965). In Michigan, its range covers the southern half of the Lower Peninsula. It is commonly found on sandy soil, growing profusely in the southwestern part of the state where it is a common species, often growing in hedge and fence rows. In the dunes along the southeastern shore of Lake Michigan, it is a frequent component of dune forests where it thrives as a small understory tree (Wells & Thompson 1982), but it does not extend as far north as the dune forests at the Sleeping Bear Dunes National Lakeshore (Thompson 1967). Although it often occurs as a small tree, large specimens are occasionally found. The records of the Michigan Botanical Club (Thompson 1975) list a large sassafras tree with a diameter of 147 cm and a height of 29 m located at the southwest edge of Jackson, Michigan on Coddington Lane.

Sassafras rarely occurs as a major component in forest communities in Michigan. I was surprised several years ago to discover a small, heavily-wooded hardwood stand on the outskirts of Detroit containing a number of large sassafras trees. The tract was located west of Evergreen Road and south of Ten Mile Road, behind television station WXYZ in Southfield, Michigan (SW1/4 NE1/4 Sec 27 of T1N, R10E), Oakland County.

The nomenclature used is that of Britton and Brown (Gleason 1952).

The woods, totaling 4 ha in area, consists of a northern sector of floodplain forest which occupies one half of the area. The southern half, on the higher ground, is covered with hardwoods containing the sassafras on relatively flat terrain. The soil of the area is Tedrow sandy loam, commonly found on old lake plains.

METHODS

To avoid the edge effect, the central portion was selected for the study area. Fifty-four 10×10 m study plots were laid out contiguously as shown in Fig. 1. Following the methods used in earlier studies (Thompson 1981, 1985), the diameter of all trees over 10 cm were measured at a height of 1.4 m. The heights of the larger trees of each species were measured with an Abney hand level. One of the larger sassafras trees was cored to determine its age.

The study tract exhibits three different site conditions. Most of the eastern section (E)

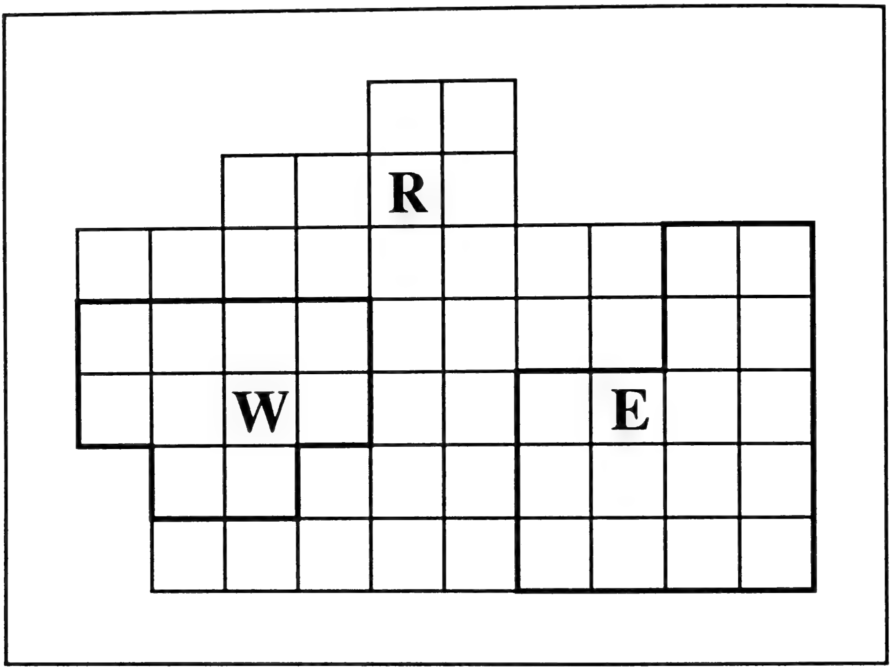

FIGURE 1. Configuration of study plots; moist eastern sector E, dry central western sector W, remainder of central mesic sector R.

shown in Fig. 1 consists of a shallow depression which temporarily accumulates water during wet periods. The central western sector (W) is more open and drier, with fewer understory plants. The balance of the tract (R) with a more developed understory appears mesic in character.

The basal area of each tree was calculated from the diameter values. The relative dominance of each species was calculated by dividing the total basal area for a given species by that of all species.

RESULTS AND DISCUSSION

The relative dominance of species for all sectors (Table 1) shows that red oak (*Quercus* borealis Michaux f.) (25%), sassafras (22%), and white oak (*Quercus alba* L.) (21%) constitute the major components of the overstory, with American elm (*Ulmus americana* L.) (9%), sugar maple (*Acer saccharum* Marshall) (6%), white ash (*Fraxinus americana* L.) (4%), red maple (*Acer rubrum* L.) (4%), and beech (*Fagus grandifolia* Ehrh.) (3%) as intermediates. Minor species include hop hornbeam (*Ostrya virginiana* (Miller) K. Koch), tuliptree (*Liriodendron tulipifera* L.), swamp white oak (*Quercus bicolor* Willd.), and basswood (*Tilia americana* L.).

The data for the different sectors reflect the different site conditions.

TABLE 1. Basal area, relative dominance, and relative density by tree species for the study area*. Data compiled separately for sector E, sector W, and sector R. N = number of trees, BA = basal area (m^2/ha), RD = relative dominance (%), D = relative density (%).

	Sector E			Sector W			Sector R			All Sectors			
Species	N	BA	RD	N	BA	RD	N	BA	RD	N	BA	RD	D
Red Oak	2	5.18	18.0	2	7.43	16.6	8	11.98	13.3	12	9.10	24.8	4.65
Sassafras	24	5.08	17.7	4	8.67	19.3	28	9.24	24.1	56	7.89	21.5	21.71
White Oak	3	2.59	9.0	12	20.07	44.7	11	6.29	16.4	26	7.86	21.4	10.08
White Elm	14	8.28	28.9	1	0.15	0.3	14	1.62	4.2	29	3.32	9.0	11.24
Sugar Maple	4	0.58	2.0	8	2.61	5.8	23	2.60	6.8	35	2.03	5.5	13.57
Red Maple	–	–	–	12	5.33	11.9	13	1.21	3.2	25	1.61	4.4	9.69
White Ash	18	3.58	12.5	1	0.35	0.7	5	0.50	1.3	24	1.38	3.8	9.30
Beech	1	0.28	1.0	1	0.12	0.3	4	2.22	5.8	6	1.23	3.3	2.33
Tuliptree	–	–	–	–	–	–	1	1.27	3.3	1	0.66	1.8	0.39
Hop Hornbeam	17	1.03	3.6	2	0.15	0.3	12	0.50	0.3	31	0.59	1.6	12.02
Swamp White Oak	1	1.71	6.0	–	–	–	–	–	–	1	0.51	1.4	0.39
Basswood	–	–	–	–	–	–	3	0.67	1.7	3	0.35	1.0	1.16
Bitternut	1	0.24	0.8	–	–	–	1	0.05	0.1	2	0.09	0.2	0.78
Blue-beech	2	0.11	0.4	–	–	–	2	0.05	0.1	4	0.05	0.1	1.55
Shadbush	–	–	–	–	–	–	1	0.08	0.2	1	0.04	0.1	0.39
Witch-hazel	–	–	–	–	–	–	2	0.05	0.1	2	0.02	0.1	0.78
Total:	87	28.66	99.9	43	4.86	99.9	128	38.33	99.9	258	36.73	100.	100.03

*Data for 54 10×10 m quadrats (0.54 ha) in Oakland County forest.

Major components for sector E are American elm (29%), red oak (18%), sassafras (18%), and white ash (13%), with substantial cover supplied by white oak (9%), swamp white oak (6%), and hop hornbeam (4%). American elm, white ash, hop hornbeam, swamp white oak, and bitternut hickory (*Carya cordiformis* (Wangenh.) K. Koch) exhibit their greatest relative dominance in this section.

Examination of the data for sector W reveals white oak (45%) is the leading dominant. Other species with high dominance are sassafras (19%), red oak (17%), and red maple (12%). Elm, ash, hop hornbeam, and beech are minor constituents. White oak and red maple show their greatest relative dominance in this section.

The data for sector R rank red oak (31%), sassafras (24%), and white oak (16%) as major components with sugar maple (7%), beech (6%), elm (4%), red maple (3%), and tuliptree (3%) providing lesser dominance. Minor species consist of basswood, white ash, and hornbeam. Red oak and sassafras, both major components in all three sectors, show their greatest relative dominance in this sector. Other species, showing their greatest cover in this sector, are sugar maple, beech, basswood, and tuliptree.

The greatest relative density for the area as a whole is exhibited by sassafras (22%) with considerable contribution from sugar maple (14%), hop hornbeam (12%), American elm (11%), white oak (10%), red maple (10%), and white ash (9%).

A considerable number of sassafras trees are distributed between different size classes, based on their diameter at breast height: large (77–39 cm), 13; medium (29–15 cm), 20; small (14–7 cm), 23.

Of the larger trees measured for height, 48 were at least 30 m high or higher and 63 exceeded 25 m in height. This suggests that this woods ranks as an old-growth forest. The 283-yr age for the cored sassafras tree, dating back to pre-settlement days, appears to confirm this contention.

In summary, the data show sassafras is a major part of the forest not only in the forest as a whole, but in each of the sectors. The woods contains a great number of large sassafras trees and this species shows the greatest relative density, and with red oak, the largest dominance.

Television station WXYZ is to be commended for their decision, through the efforts of The Nature Conservancy, to preserve this unusual tract.

ACKNOWLEDGMENTS

I wish to thank Cranbrook Institute of Science for research funds and for J. R. Wells of that institution for assistance in determining the age of the sassafras tree. My thanks to Burton Barnes of the University of Michigan for his many helpful suggestions.

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ERRATUM

The date of death given for Joseph M. Beitel on page 3 of Vol. 30 (no. 1) is incorrect; the correct date is 22 February 1991.

OBITUARY

Arthur Cronquist (1919–1992)

The staff of *The Michigan Botanist* joins with the Board of Managers and Staff of the New York Botanical Garden in expressing sorrow at the passing of Dr. Cronquist on 22 March 1992. Best known to our readers as the co-author of the *Manual of Vascular Plants* (the new edition reviewed in the last number (Vol. 30 # 4)), Dr. Cronquist had also devoted much time and energy on other projects including the study of plant relationships, systematics of the Asteraceae, and the Flora of the Intermountain Region in the western United States. The New York Botanical Garden has established The Arthur Cronquist Fund to further research in the latter two areas.

REVIEW

THE DICOTYLEDONEAE OF OHIO, volume 2, part 3: ASTERACEAE. By T. Richard Fisher. Ohio State University Press, 1070 Carmack Road, Room 180 Pressey Hall, Columbus, OH 43210. 1988. xiii + 280 pp. $65.00.

The "Vascular Flora of Ohio Series" made its debut with volume I, "The Monocotyledoneae, Cat-Tails to Orchids" by E. Lucy Braun, in 1967. (That volume is still in print and available at the above address for $42.00.) The present work on the Asteraceae of Ohio continues in the fine tradition begun by E. Lucy Braun and deserves a place beside it on one's shelves.

Fisher's book is entirely conventional: keys to tribes, (with keys to the genera of each tribe at the appropriate position in the book), followed by keys to genera irrespective of tribes (this doubling-up makes the book much more accessible to all), followed by keys to the species under each genus. In the keys toward the front of the book, every tribe (or genus, as the case may be) is followed by a page number, an excellent convenience to the reader.

The sequence of tribes is phylogenetic, as is the sequence of genera and species. Species descriptions are brief but carefully honed; where the genus is monotypic in Ohio, the generic description suffices to describe the species. Nearly every species is skillfully illustrated (the drawings are all originals, by Sharon Ames Glett, with some in *Solidago* by Ellen Powell), and nearly every species is accompanied by a range map of its Ohio distribution. Save for brief references to origins of introduced species, (fully one-third of the species), neither the maps nor the text makes any reference to extra-Ohio distribution; the author obviously assumes one has other standard sources at hand. The maps and illustrations (neither referred to in the text at all!) are occasionally a bit tricky to find; sometimes they both fall on the same or facing page, sometimes not.

The book, printed on a creamy paper that permits some minimal show-through, is free of both solecisms and printing errors; the author, editors, and publisher are to be congratulated. One eagerly awaits the appearance of parts 1 and 2 of volume 2, "Saururaceae through Leguminosae" by John Furlow, and "Linaceae through Campanulaceae" by Tom Cooperrider; both volumes are in preparation.

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SCUTELLARIA NERVOSA (LAMIACEAE), A SPECIES OF SKULLCAP NEW TO MICHIGAN

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Scutellaria nervosa Pursh (veined skullcap) is a spring-flowering perennial herb occurring in rich woods from New Jersey to southern Ontario, Illinois, and Iowa, south to Virginia, the mountains of western North Carolina and eastern Tennessee, Alabama, and Louisiana (Epling 1942, Gleason 1952). It is distinguished from the other species of *Scutellaria* occurring in the northeastern United States and adjacent Canada by its solitary flowers in the axils of normal foliage leaves and its sessile or nearly sessile ovate-lanceolate to round-ovate leaves, as well as its uppermost sterile leaves which are 2–4.5 cm long and conspicuously serrate. The flowers are about 9–11 mm long, thus distinctly smaller than in *S. galericulata* and larger than in *S. parvula*. Gleason (1952) recognizes two varieties of *S. nervosa*: var. *nervosa*, which has leaves with strigose upper surfaces, and var. *calvifolia* Fern. which has leaves glabrous above. Despite the presence of *S. nervosa* in De Kalb County of northeastern Indiana (Deam 1940), Kankakee County of northeastern Illinois (Mohlenbrock & Ladd 1978), and two sites in Essex County of southeastern Ontario (Morton & Pryer 1987), until now it has not been collected in Michigan (E.G. Voss, pers. comm.).

On July 22, 1989, *S. nervosa* var. *calvifolia* (*Fritsch 1141*, MICH) was collected from a rich woodland near the St. Joseph River, 2.5 km north of the Ohio border, in Section 31, T8S, R3W, Hillsdale County, Michigan. The locality originally may have been part of the floodplain, but presently it is separated from the river by a cultivated field and two roads. A small swamp borders the locality to the north and a beech-maple woods to the east. The soil at the locality is a black loam with little or no organic layer. Associates seen on August 7, 1990, included *Acer saccharum* Marshall, *Anemone canadensis* L., *Carya cordiformis* (Wangenh.) K. Koch, *Circaea lutetiana* L., *Cornus alternifolia* L. f., *C. stolonifera* Michaux, *Cryptotaenia canadensis* (L.) DC., *Galium triflorum* Michaux, *Geranium maculatum* L., *Geum canadense* Jacq., *Laportea canadensis* (L.) Wedd., *Ostrya virginiana* (Miller) K. Koch, *Parthenocissus quinquefolia* (L.) Planchon, *Phlox divaricata* L., *Quercus rubra* L., *Rosa multiflora* Murray, *Sanguinaria canadensis* L., *Sium suave* Walter, *Smilacina racemosa* (L.) Desf., *Smilax lasioneura* Hooker, *S. tamnoides* L., *Tilia americana* L., *Ulmus americana* L., *U. thomasii* Sarg., and *Verbesina alternifolia* (L.) Britton. At that time only thirteen stems of the plant were counted within a total area of not more than 0.1 m^2. Searches of nearby localities with similar habitat have not revealed any other populations of this species.

Scutellaria nervosa is considered rare in Canada, Arkansas, Maryland, New Jersey, New York, North Carolina, South Carolina, and Virginia (Morton & Pryer 1987). In addition, it has been collected only rarely from northeastern Illinois (Mohlenbrock & Ladd 1978) and northern Indiana (Deam 1940). All these areas are located on the edge of the species' range. Therefore, the finding of a small, apparently isolated population of *S. nervosa* in extreme southern Michigan is consistent with the distribution pattern previously documented for this species, since Michigan is situated at the species' northern boundary. Given the rarity of *S. nervosa* in and adjacent to Michigan, any additional discoveries of populations in Michigan would be significant. These populations most likely will appear in the floodplains and moist woods in the extreme southern part of the state.

ACKNOWLEDGMENTS

This discovery was made in connection with a grant from the Hanes Fund. Thanks to E.G. Voss and A.A. Reznicek, who confirmed the identity of the specimen.

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EDITOR'S NOTE

THE MICHIGAN BOTANIST: What's it made of?

While it is obvious that many of the articles that appear in *THE MICHIGAN BOTANIST* relate in some way to preservation of our environment, it is probably not obvious that the paper and ink used for these articles also help in the cause.

THE MICHIGAN BOTANIST is printed by Thomson-Shore, Inc. at their plant in Dexter, Michigan. Not only are they known for the production of high quality short-run books and journals, but they are taking steps to make their products more environmentally friendly. The paper that you are now reading is an acid-free stock made from 80% recycled stock. While the acid-free feature is especially important for archival preservation of the journal, the fact that it is also a recycled paper makes environmental sense. The ink used in printing THE BOTANIST is soy based. That's right, not petroleum, but soybeans. Thomson-Shore now uses 100% soy based inks for all of their black and white printing. Inks emit a vapor that includes volatile organic compounds thought to be culprits in ozone depletion. The emission of these compounds from soy based inks is only a small fraction of that coming from traditional petroleum based inks.

MUHLENBERGIA RICHARDSONIS IN WISCONSIN

Thomas L. Eddy
426 Walker Avenue
Green Lake, WI 54941

and

Neil A. Harriman
Biology Department
University of Wisconsin-Oshkosh
Oshkosh, WI 54901

The grass flora of Wisconsin was last treated in its entirety by Fassett (1951). Since then, a number of adventive grasses have been discovered (Harriman 1971, Solheim & Judziewicz 1984, Freckmann et al. 1988), but there have been no additions to the native grass flora of the state.

Muhlenbergia richardsonis (Trin.) Rydberg may now be added to the Wisconsin flora:

> **WISCONSIN**. GREEN LAKE CO.: Berlin Fen on E side of Willard Road, just S off state rt. 116, Sec. 12, T17N, R13E, 27 Aug 1989, *Harriman 18944* & *Thomas Underwood* (OSH, WIS).

It appeared initially that this inconspicuous grass was represented by only a few individuals; but subsequent visits revealed that the grass is quite abundant in this calcareous fen. Its associates include *Potentilla fruticosa* L., *Sarracenia purpurea* L., *Scleria verticillata* Muhlenb., *Tofieldia glutinosa* (Michaux) Pers., and *Triglochin palustris* L.

Berlin Fen is preserved as a Wisconsin Department of Natural Resources scientific area; hence, there is no likelihood of its being bulldozed or plowed. The earlier surveys that led to preservation of the site evidently did not detect this grass.

There is another calcareous fen a few miles to the west (Sec. 14, T16N, R12E) with the same array of characteristic fen species, but *M. richardsonis* was not detected there, despite an intensive search for it.

Muhlenbergia richardsonis is a well-marked species. The spikelets are awnless, lemmas neither pilose at base nor with hairs across the back, leaf ligules are regularly 1.5– 2.5 mm long, and the plants lack rhizomes.

The known range of this species (Scoggan 1978) is from southern Yukon to British Columbia, Alberta, Saskatchewan, Manitoba, northern Ontario, eastern Quebec, New Brunswick, and Maine, three counties in Michigan (Voss 1972), thence from Minnesota west to the Pacific and south to Baja California; it is not reported for Wisconsin in the usual floras (Chase 1951, Fassett 1951, Fernald 1950, Gleason & Cronquist 1963), nor are there any other records for this species in the major herbaria of Wisconsin.

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ANNOUNCEMENT

THIRTEENTH NORTH AMERICAN PRAIRIE CONFERENCE

Spirit of the Land: Our Prairie Legacy

August 6–9, 1992 — Windsor, Ontario

This year, the North American Prairie Conference is being held in Windsor, Ontario, a location that will be very convenient for interested MBC members. This is the first time this meeting has been held outside of the United States. Organizations that have cooperated in the planning and/or administration of the conference include the Walpole Island First Nation — the Council of the Three Fires, the City of Windsor Department of Parks and Recreation, the Ontario Ministry of Natural Resources, the University of Windsor, and the Canadian Wildflower Society.

Contributed papers, symposia, landscape design and photographic competitions, and exhibits are among the activities that will take place on the University of Windsor campus. The aim of the organizers is to present "a fully developed conference programme which covers all aspects of the prairie environment." Field trips to prairie areas in Ontario, Ohio, and Michigan are planned as well as training workshops, e.g., grass/sedge identification.

Anyone interested in attending the conference is invited to write Paul Pratt at the following address to receive information on conference registration and fees, information on field trips and workshops, and room and board arrangements.

Paul Pratt
Department of Parks and Recreation
2450 McDougall
Windsor, Ontario
CANADA N8X 3N6

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NOTEWORTHY COLLECTION

ONTARIO

TARAXACUM PALUSTRE (Lyons) DC., sensu lato. (Asteraceae). Marsh Dandelion.

Previous knowledge. Brunton (1989) reported the first verified collections of a species of *Taraxacum* Section *Palustria* Dahlst (*T. palustre* (Lyons) DC., s.l.) in North America, from eastern Ontario, western Quebec and northern New York state. At that time, the microspecies involved was identified as *T. turfosum* (Schultz-Bip.) Soest.

Significance. These collections extend the known distribution of *T. palustre* southward and westward in Ontario, and add eight new county records. Additional study of these dandelions has suggested that they belong to the microspecies *T. cognatum* Kirschner & Stepanek (J. Stepanek, pers. comm., 1990), rather than *T. turfosum* as reported previously (Brunton 1989). *Taraxacum cognatum*, which was recently described by Kirschner and Stepanek (1986), is native to rivershores and fens in eastern Hungary and southcentral Czechoslovakia. It appears that the European dandelions have been divided into numerous poorly differentiated species, now often referred to as microspecies. Currently many systematists consider it best to lump the microspecies into more well defined species and we conform to this trend in using the name *T. palustre*. The additional Ontario records and reports from Connecticut (O. Stewart, pers. comm., 1990) suggest that marsh dandelions should be looked for elsewhere in the province and in northern states.

Diagnostic characters. *Taraxacum* Section *Palustria* can be distinguished from other introduced North American *Taraxacum* by their erect, narrow, remotely serrate leaves (vs. deeply cut and reflexed leaves in most introduced *Taraxacum* taxa in North America), and very dark, broad, and strongly appressed exterior involucral bracts (Brunton 1989).

ONTARIO, ELGIN CO.: Port Burwell Provincial Park campground, Port Burwell, Bayham Township, 14 May 1990, *Oldham 10717* (MICH, TRTE, UWO, WAT, dfb—D.F. Brunton personal herbarium). HALDIMAND-NORFOLK REGIONAL MUNICIPALITY: Long Point Provincial Park campground, Norfolk Township, 16 Apr 1991, *Oldham 12303* (TRTE). HURON CO.: 5.3 km NW of Clinton Post Office, Goderich Township, 22 Apr 1991, *Oldham 12331* (MICH). KENT CO.: Wheatley Provincial Park campground, Romney Township, 25 Apr 1991, *Oldham 12336* (MICH). MIDDLESEX CO.: Dorchester Swamp, 5.5 km SE of Dorchester Post Office, Lot 11, Concession I, North Dorchester Township, 10 June 1990, *McLeod 9069* (UWO). MUSKOKA DISTRICT: 7.5 km W of Gravenhurst Post Office, just W of Loon-Turtle Creek, near N end of Muldrew Lake, Wood Township, 3 May 1990, *Sutherland 8874 & Bowles* (TRTE). OXFORD CO.: 5.8 km W of Princeton Post Office, Blandford-Blenheim Township, 13 May 1990, *Oldham 10700* (MICH). SIMCOE CO.: Springwater Provincial Park, 8 km NW of Barrie Post Office, Vespra Township, 8 May 1990, *Oldham 10657* (MICH, DFB).

Generally in open, disturbed, frequently moist ground, often with *Taraxacum officinale*. This is a plant of wet, usually calcareous and/or salt-rich substrates such as ditch bottoms. Most non-native *Taraxacum* in north-eastern North America occupy drier situations. It is also one of the earliest flowering *Taraxacum* taxa in the Great Lakes region. *Taraxacum palustre* has been found as a weed in campgrounds and picnic areas in four different provincial parks, and as a lawn weed in five different locations. Abundance varies from one to several dozen plants per site. Only one collection per county is cited above, although additional locations are known for several counties. Collection data for localities not listed here are available from the senior author.

ACKNOWLEDGMENTS

We would like to thank J. Stepanek for information and identifications, O. Stewart for data on North American collections, and P.M. Catling for helpful comments on the manuscript.

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REVIEWS

CONSERVING CAROLINIAN CANADA: CONSERVATION BIOLOGY IN THE DECIDUOUS FOREST REGION. By Gary M. Allen, Paul F. J. Eagles, and Steven D. Price, editors. 1990. Waterloo, Ontario: University of Waterloo Press. US $28.00

Conserving Carolinian Canada provides a collective summary of a joint conservation program launched in 1984 by the World Wildlife Fund (Canada), the Ontario Heritage Foundation, the Nature Conservancy of Canada, and the Richard Ivey Foundation to document the threatened resources and provide a coordinated research strategy for the Carolinian Forest Zone of Ontario. Canada's Carolinian Zone extends along the northern shores of Lakes Erie and Ontario and represents part of the much larger Eastern Deciduous Forest that extends throughout much of the eastern half of the United States. With dominant tree species and other plants and animals not found elsewhere in Canada, the Carolinian life zone contains more endangered species than any other Canadian life zone. As noted by the study, it is also home to most intense agriculture and urban development in Canada with 25% of Canada's entire population living within its boundaries. Because of the zone's unique resources and development pressures, the Carolinian Canada Program was initiated to identify and rank critical natural areas, recommend strategies for protection of habitats and the endangered and threatened species supported by them, and to develop an interagency policy structure for coordinating conservation efforts. The papers included in *Conserving Carolinian Canada* were presented at a workshop held on 15 January 1988 at the University of Waterloo.

Papers included in *Conserving Carolinian Canada* cover an array of conservation topics ranging from the presentation of results from inventory and assessment programs, to studies on particular plant or animal species, to reports on reintroduction programs for various bird species, to a general discussion of creating data centers for coordinating research and disseminating information both to researchers and managers. There are several common threads in all of these papers that are critical to any successful conservation effort: the emphasis on networking and the exchange of information, the recognition of the magnitude of the conservation problem and need to work on preserving habitats at a landscape scale, and the creative development of partnerships between scientists, landowners, and the public at large. Numerous papers point to the use of volunteers both in doing field work as well as in compiling and analyzing collected information. Most notable, perhaps is the Ontario Rare Breeding Program, reported in a paper by Michael Cadman. In this five year program, more than 1300 volunteers gave over 180,000 hours of field work and produced some 400,000 records in inventorying the avian resources of Ontario. Michael J. Oldham reports on a similar effort to inventory herpetofaunal species, and Steve Varga and Gary M. Allen note the network of volunteers and professionals working to provide vascular plant floras for the counties/regional municipalities of the Carolinian Zone.

As a group, the papers included in *Conserving Carolinian Canada* provide a detailed look at conservation issues from varying scales. In addition to the regional surveys already mentioned, papers on particular natural areas such as Sassafras Woods in Halton, Ontario and Walpole Island Indian Reserve provide useful analyses of particular sites and the unique array of opportunities and constraints that makes effective conservation of these areas difficult. For example, P. Allen Woodliffe and Gary M. Allen note the rich mosaic of habitats found on Walpole Island's approximate 24,000 hectares and suggest that the prairie/savannah habitats found on Walpole Island may be the most significant remnants of these plant communities in all of Canada, if not North America. Members of the reserve are to be credited with preserving these natural habitats through annual burning, yet Walpole Reserve must contend with unemployment rates near 60% and is under increasing pressure to derive economic benefits from its land resources. Other papers record research on the ecology of individual plant and animal species such as John D. Ambrose and Peter G. Kevan's paper "Reproductive Biology of Rare Carolinian Plants with Regard to Conservation Management," Kevin Kavanagh's paper "A Comparison of the Population Ecology of *Liriodendron tulipifera* L. (Tuliptree) Among Allopatric Populations: Preliminary Recommendations for its Conservation in Ontario," and Laurence Packer's paper "The Status of Two Butterflies, Karner Blue (*Lycaedes melissa samuelis*) and Frosted Elfin (*Incisalia irus*), Restricted to Oak Savannah in Ontario."

Conserving Carolinian Canada should have immediate appeal to those living within the Carolinian Zone as well as all others concerned with the individual species or habitats described in its papers. As a group, the collection provides a broad understanding of the problems facing these resources as well as suggestions for action. While the detail and depth of individual papers is not consistent across the collection, all papers include useful references for further study on a given topic. In addition, the papers are presented in such a way so that the information is clearly understandable by layperson or trained scientist, and carefully drawn maps and drawings of plants and animals make the region legible for someone not familiar with the territory. Perhaps the most notable contribution by this collection of papers is its presentation of a conservation strategy, by necessity a team effort, placing individual scientific investigations in a larger context and recognizing the need for continued dialogue and sharing of information among politicians, scientists, and the general public. It records a model partnership of conservation funding and networking that is unique, but increasingly critical for the continued success of any effective conservation program. This last feature should serve to make *Conserving Carolinian Canada* useful well beyond the geographic borders of Southern Ontario.

—Robert E. Grese
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FRONTIER BOTANIST. William Starling Sullivant's Flowering-Plant Botany of Ohio (1830–1850). Ronald L. Stuckey and Marvin L. Roberts. Sida, Botanical Miscellany, 6. Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102. 1991. x + 65 pp. $10.00 postpaid; checks payable to "Sida."

Histories are important; they help us put taxonomic work into a context, and they help to sort out nomenclatural puzzles. Botany owes a great debt to our modern biohistorians, like Rogers McVaugh, Joseph Ewan, and Ron Stuckey, ably assisted by his long-time friend and student, Marvin Roberts.

The present work is a pure labor of love, replete with photographs, maps, and illustrations of species named for Sullivant as well as species first collected by him and communicated to others. Some of the most welcome illustrations, because they are otherwise unavailable, are of the Sullivant home, children, wives (3), and ancestors.

There is botany aplenty, including numerous historical tidbits surrounding the discovery and publication of *Sullivantia sullivantii.*

The six appendices are invaluable. Most of the technical botany is here, including discussions of Sullivant's associates, lists of plants named by him and lists of those named by others, rarities first discovered by him, and documented localities where he collected. The authors are especially to be congratulated on providing an extensive index.

Throughout, the book is a graceful melding of anecdote and carefully selected excerpts from letters in archives. The book will be of interest to those concerned with taxonomic botany and to those seeking a model of how a small but important piece of biohistory should be written.

—Neil A. Harriman
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EDITOR'S NOTE
SUBSCRIPTION PRICE INCREASE

Effective with Volume 32 #1 (January 1993), the subscription rate will be raised from **$10.00** to **$16.00**. While no price increase is welcome news, this one is based on economic necessity. This is the first increase in our subscription rate in 10 years, a statement that most journals comparable to *The Michigan Botanist* cannot make. We have absorbed increases in paper and production charges; in part these have been offset by shopping for (and finding!) lower rates without sacrificing the quality of the journal. Our postage bill continues to climb; our mailing rate rose about 20% when the rates were last changed. The $16.00 figure was in part proposed to prevent asking for another increase for several years—we hope.

We believe that *The Michigan Botanist* subscription rate is still quite reasonable when compared to similar journals and it is our intent to maintain that position.

—The Staff of *The Michigan Botanist*

EDITOR'S REPORT

With the appearance of the October, 1991 issue (Vol. 30, no. 4), I have now had a major role in bringing three volumes of *The Michigan Botanist* from a series of typed manuscripts to the form that you see in these pages. While it is a rewarding experience, some frustrations do accompany the task. I'd like to take a few lines to address several items that, with a bit of help from our readers, would become easier to deal with.

"Why aren't there more announcements of events, meetings, etc. in *The Botanist*?" Two reasons come to mind—I don't know about a particular event (the major reason) or I receive the information too late to use it. I can only publicize events that I learn about, mostly via mailings that I receive. If you want an event to appear in *The Botanist*, tell me about it. While the long lead time necessary to prepare each issue may limit what can be included, meeting announcements are both informative to our readers and VERY handy as "filler" to fill out pages, etc.

Address correction and "returned" issues. Each time an issue of *The Botanist* is mailed, I can count on receiving a small number of copies that could not be delivered. The postage we pay for each return is greater than that spent to mail the issue. PLEASE MAKE SURE WE HAVE YOUR CORRECT ADDRESS. If you are planning to move (or even to be "temporarily away" as the USPS phrases it), notify your chapter, state membership chair, or subscription agent as appropriate. In an effort to reduce costs, we are considering applying for different mailing privileges that would NOT include the return of undeliverable copies; correct addresses would be essential!

Return of manuscripts and book reviews. I again appeal to authors to return book reviews and manuscripts that have been returned for correction as promptly as reasonably possible. Any papers not returned within one year of acceptance are subject to additional reviews (and thus, delays).

Return of manuscripts, photos, etc. to authors. It would be a great help to me if all authors would indicate if they would like any submitted material returned after it is published. While I do so for local authors, I don't for out-of-town authors in an attempt to save postage.

—Richard K. Rabeler

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We wish to thank the following people who reviewed articles for *The Michigan Botanist* during 1991. Their comments were essential, helping our authors to prepare clear, succinct text and to us in our position as editors. Their assistance is gratefully acknowledged.

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CONTENTS

On the cover: *Reindeer Lichen* (Cladina arbuscula)
Photographed by Sandra Planisek

Vol. 31, No. 2

THE MICHIGAN BOTANIST

March, 1992

THE MICHIGAN BOTANIST (ISSN 0026-203X) is published four times per year (January, March, May, and October) by the Michigan Botanical Club, c/o Herbarium, North University Building, The University of Michigan, Ann Arbor, MI 48109-1057. Second-class postage paid at Ann Arbor, MI. POSTMASTER: Send address changes to *THE MICHIGAN BOTANIST*, c/o Herbarium, North University Building, The University of Michigan, Ann Arbor, MI 48109-1057.

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Articles dealing with any phase of botany relating to the Great Lakes Region may be sent to the Co-editors. In preparing manuscripts, authors are requested to follow our style and the suggestions in "Information for Authors" (Vol. 28, p.43; Vol. 29, p.143).

THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora; establishment suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Dues are modest, but vary slightly among the chapters and with different classes of membership. Persons desiring to become state members (not affiliated with a local chapter, for which contact persons are listed below), may send $13.00 ($25 for 2 years) dues to the Membership Chairperson listed below. In all cases, dues include a subscription to *THE MICHIGAN BOTANIST*. (Persons and institutions desiring to subscribe without becoming members should deal directly with the Business and Circulation Manager.)

ELEMENTAL COMPOSITION OF SOUTHWEST MICHIGAN MOSSES AS MEASURED BY PROTON INDUCED X-RAY EMISSION (PIXE) ANALYSIS

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INTRODUCTION

The elemental composition of mosses has been studied using a variety of techniques (Shacklette 1965), many of which require analyzing samples for one element at a time. Multi-element instrumental analysis by proton induced x-ray emission (PIXE) was developed in 1970 (Johansson & Campbell 1988). It has been applied to a wide variety of biologic, geologic, and atmospheric samples but has not previously been applied to mosses. The purpose of this paper is to provide data from the first application of the PIXE method to bryophytes, compare the results achieved with portions of the world literature, and establish a baseline against which future changes in the elemental composition of mosses in southwest Michigan caused, in part, by atmospheric pollution can be measured.

Bryophytes and mosses in particular are interesting to study with the PIXE method because they are very effective in picking up contaminants, particularly heavy metals, from surrounding air, water, and soil (Tyler 1971). Mosses have a high capacity for absorbing nutrients from the air and retaining them (LeBlanc & Rao 1974, Rasmussen 1977, Steinnes 1980, Puckett 1988) making them ideally suited for monitoring air pollution in an area. Rasmussen (1977), using epiphytic bryophytes, demonstrated a rise in heavy metal concentrations over a 25-year period in relation to increased industrialization and the combustion of fossil fuels.

In Michigan, the major industrial development of the state is in the southeast. The southwestern part of the state is primarily agricultural, with corn, soybeans, other row crops, vineyards, and orchards occupying large tracts of land. Some portions are covered with second growth forest and pine plantations. Southwestern Michigan has scattered industrial development relating to pharmaceuticals, paper making, plastics, and auto parts. It is anticipated that industrialization will increase in the future as will vehicu-

lar traffic. The increased industrialization will likely result in increased air and water pollution. This increase can be monitored in a variety of ways including changes in the elemental composition of mosses. This paper will provide a base-line against which such changes can be measured.

The PIXE system is useful in this regard because it can yield results for many elements in a single 5-minute run. Other techniques are much more time consuming and expensive and frequently yield results for only a single element. Access to accelerators on university campuses or in nearby laboratories has made PIXE a cost-effective method for determining the elemental composition of an increasing variety of materials. It is hoped that this paper will stimulate others to apply the PIXE system to mosses and thereby increase the base-line data against which pollution-induced changes in elemental composition can be measured.

MATERIALS AND METHODS

The multi-element aspect of PIXE arises from the nature of the interaction of a proton beam with a sample. As protons impact atoms of the sample, electrons are dislodged from inner electron shells. Electrons from outer shells move in to replace them, giving off x-rays which dissipate the energy differential between outer and inner shell electrons. The x-ray spectrum given off is diagnostic for the element of the atom affected. With a steady stream of protons striking the target's many atoms and computer analysis of the resultant spectra, it is possible to determine the nature of the elements present and their amounts. Toward this end moss samples were prepared for exposure to the proton beam.

Samples of seven species of mosses were collected on May 22 and 25, 1988 at three locations in Kalamazoo and Van Buren counties. The location in Kalamazoo County was in the Gourdneck Game Preserve, 2.0 mi WSW of Portage. The Van Buren County collections were taken at Whiskey Run and Wolf Lake, both 11.5 mi W of Kalamazoo. Environments from which the collections were made are shown in Table 1. The samples were selected on the basis of ease and certainty of identification, access to the site, and likelihood that the populations sampled would endure. Collections were large enough to insure that more than 100 plants would be available for analysis in each sample. They were temporarily stored in polyethylene bags and all sample handling was done with disposable polyethylene gloves. Voucher specimens are deposited in the Hanes Herbarium (WMU) at Western Michigan University. Nomenclature for the species collected follows that of Crum (1983).

Individual plants were removed from the collections and examined at 20× magnification to insure that the PIXE samples were not contaminated by soil, humus, or other extraneous matter. Such contaminants were removed with a camel's hair brush. With sub-aerial samples it is counterproductive to wash or rinse plants prior to analysis (Smith, 1986). As Puckett (1988) pointed out, ". . . any pre-treatment which tends to remove deposited abiotic material of natural or anthropogenic origin will result in an under-estimate of the metal deposition." The cleaned and air-dried plants were pulverized with a marble mortar and pestle.

The ground plants were pressed into pellets with a hydraulic press at 2000 psi and stored in glass screw-top vials until the time of PIXE irradiation. Parts of more than 100 plants were included in each pellet. The pellets were disk-shaped, 12.5 mm in diameter, and varied from 1.0 to 10.0 mm in thickness. Thinner pellets were backed by compressed tissue paper to insure stability during irradiation. Pellets were loaded onto a six-step sample ladder constructed to allow exposure of one pellet at a time to the proton beam. The beam of 3 MeV protons was generated by the tandem Van de Graaff accelerator at Western Michigan University. Each pellet was irradiated until 20 microcoulombs of charge were accumulated, approximately five minutes.

The spectra of x-rays emitted during the irradiation of each pellet were measured by a lithium drifted silicon detector [Si(Li)]. X-rays entered the detector through a filter designed to produce reasonable sensitivities over the range of elements of interest. If the full range of x-rays were allowed to reach the detector, then x-rays from the major elements would overwhelm

TABLE 1. Location and environment of moss samples for PIXE analysis. See text for details on locations. Collection numbers are those of the voucher specimens. Abbreviations of the names of species are those used in Table 3.

Species and Abbreviation	Collection Number	Location	Environment
Atrichum angustatum (Brid.) BSG.			
ATR	7221	Whiskey Run	Soil in streamside woods.
Climacium dendroides (Hedw.) Web. & Mohr.			
CLI	7222	Whiskey Run	Soil in streamside woods.
Leucobryum glaucum (Hedw.) Angstr. ex Fries			
LEU	7225	Gourdneck	Soil along trail in woods.
Mnium affine Bland ex Funck. var. *ciliare*			
MNA	7230	Wolf Lake	Peaty soil in woods.
Mnium cuspidatum Hedw.			
MNC	7229	Wolf Lake	Peaty soil in woods.
Polytrichum commune Hedw.			
POL	7217	Wolf Lake	Soil in woods.
Thuidium delicatulum (Hedw.) BSG.			
THU	7214	Whiskey Run	Rotting log in woods.

those from the trace elements (Cahill 1975). The filter blocks the low energy x-rays from the light major elements (H, C, O, N, and Si) and reduces the number of medium energy x-rays from the medium weight major trace elements (Ca, K, and Fe) so that a reasonable number of higher energy x-rays from the minor trace elements can be counted.

The system passes the Si(Li) signals through a computer which generates a spectrum. The individual peaks of the spectrum are analyzed by the computer, background is separated out, and the results are printed out as parts per million of dry weight for each element detected along with a calculation of the percent uncertainty which relates to each measurement.

Since both the impact of the proton beam and the analysis of the resultant x-rays involve statistical phenomena, the computer calculates the equivalent of the standard deviation. This is combined with other factors such as spectrum peak overlap, detection geometry, self absorption, and scatter to produce the percent uncertainty readings. These readings do not bear upon whether or not a particular element is present in the sample, but rather, on how much of that element is present. To facilitate comparisons between samples and between elements, the data from the print-outs were organized into a table using Visi-Calc software and an IBM-PC.

The accuracy and effectiveness of the WMU PIXE system, on the days during which samples were irradiated, was checked by irradiating several pellets made from National Bureau of Standards (NBS) standard # 1571, orchard leaves gathered from an orchard near Lansing, MI and analyzed by the NBS. The results of these test runs and their comparison with the NBS published values are presented in Table 2. Samples of the polyethylene bags and gloves were also analyzed to insure that contaminants were not introduced from these sources.

RESULTS AND DISCUSSION

For every element measured in the NBS standard, the average values produced by the PIXE system overlap with those published by the NBS. Copper and zinc illustrate this well. The PIXE averages are 12 ppm ± 2 and

TABLE 2. Comparison of PIXE analysis of NBS Standard # 1571 with NBS published values. All values are in ppm dry weight. PIXE uncertainty percentages are given in parentheses ( ) and equated to ± ppm rounded to the nearest ppm. The NBS values for Bromine and Zirconium are uncertified and ± data are lacking.

Element	Three PIXE Samples of NBS # 1571	Average of Pixe Samples	NBS Published Values
K	16195 15266 13808 (25)	15090 (25% = ± 3773)	14700 ± 300
Ca	21189 21768 19785 (25)	20914 (25% = ± 5229)	20900 ± 300
Mn	87 96 83 (25)	89 (25% = ± 22)	91 ± 4
Fe	303 317 290 (15)	303 (15% = ± 45)	300 ± 20
Cu	12 13 12 (16)	12 (16% = ± 2)	12 ± 1
Zn	26 27 24 (15)	26 (15% = ± 4)	25 ± 3
As	13 12 9 (50)	11 (50% = ± 6)	10 ± 2
Br	9 9 10 (31)	9 (31% = ± 3)	10
Rb	14 12 13 (16)	13 (16% = ± 2)	12 ± 1
Zr	37 37 32 (15)	35 (15% = ± 5)	37
Pb	74 42 40 (20)	52 (20% = ± 10)	45 ± 3

26 ppm ±4, respectively. The nearly coincident NBS published values are 12 ± 1 and 25 ± 3.

It is also apparent from the data in Table 2 that the PIXE system is overestimating the percent uncertainty that relates to each of its determinations. In every case, the variance represented by the PIXE percent uncertainty is greater than that found by the NBS, even though the ppm determinations for the elements themselves are very close. For instance, with the NBS determination of 300 ppm Fe ± 20 based on the use of four different methods of analysis and the PIXE determination of 303 ppm Fe ± 45, it is likely that ± 20 is a more reliable measure of the variance than is ± 45. This becomes clearer as additional elements are considered. Calcium, for instance, is determined at 20900 ppm ± 300 by the NBS using two different techniques and at 20914 ppm ± 5229 by PIXE. Again, the near coincidence of the values 20900 and 20914 suggests that ± 300 is a more reliable estimate of the variance than is ± 5229. Nevertheless, the percent uncertainties developed by the PIXE system are given with all subsequent PIXE data. The reader is asked to remember that these estimates are probably systematically inflated.

The data in Table 3 present the PIXE measurements of twelve elements in seven species of mosses in southwest Michigan. Considerable variation in the elemental composition of the seven mosses was found. For potassium, *Leucobryum* was substantially lower than the other genera and *Mnium affine* higher. For calcium, *Atrichum, Leucobryum*, and *Polytrichum* ranged from 2252 to 7466 ppm while *Thuidium, Climacium*, and both species of *Mnium* ranged from 10146 to 12668 ppm. Iron, the third most abundant of the elements measured, ranged from 484 to 891 ppm in

Mnium, Leucobryum, Polytrichum, and *Atrichum* and from 1101 to 1884 ppm in *Climacium* and *Thuidium*. The readings for manganese ranged from 55 to 85 ppm in *Atrichum, Leucobryum*, and *Thuidium* and from 122 to 364 ppm in *Polytrichum, Climacium*, and *Mnium*. For titanium, the values ranged from 22 to 75 ppm in *Mnium, Atrichum, Polytrichum*, and *Leucobryum* and from 117 to 153 ppm in *Thuidium* and *Climacium*.

All genera gave readings substantially below 100 ppm for copper, zinc, bromine, rubidium (except for *Mnium affine* at 105 ppm) strontium, zirconium, and lead. Of these, zinc and rubidium were most abundant and copper and bromine least. Additional elements were present in these mosses but at concentrations below the detection level of the PIXE system. The same collections are being examined by neutron activation analysis to determine the abundance of the trace elements.

It is known (Schofield 1985) that the mineral nutrient requirements of mosses are similar to those of vascular plants. In addition to major requirements for carbon, hydrogen, nitrogen, and phosphorus, mosses require lesser amounts of potassium, calcium, manganese, iron, copper, and zinc (Nash & Egan 1988). The roles of titanium, bromine, rubidium, strontium, and lead are still controversial (Kabata-Pendias & Pendias 1984). Thus, titanium may be involved in photosynthetic and nitrogen fixation enzymes in some plants and rubidium and strontium may serve as replacements for potassium and calcium, respectively.

The data in Table 3 make it clear that the capacity to absorb and retain mineral matter and/or to collect and retain particulates varies considerably from one type of moss to the next and that this capacity varies by element as well. This is likely the result of the interplay of three variables: the microenvironment in which the moss is growing, physiological variation in its absorption/retention capabilities, and its morphological structure and growth habit. The last variable is probably the most significant since it directly affects the mosses' ability to trap and retain particulate matter.

All species selected for this study have morphological attributes which should enhance their ability to trap and retain particulate matter. The erect growth habit of *Atrichum, Climacium, Leucobryum*, and *Polytrichum*, the tendency of these taxa to form clumps, and the leaf lamellae of *Atrichum* and *Polytrichum*, should serve these ends. Both species of *Mnium* have broad, horizontally deployed leaves. The stems and branches of *Thuidium* are covered with filamentous paraphyllia. There have not yet been sufficient studies completed to relate these characteristics to the retention of particular elements.

Table 4 presents a comparison of the concentrations of selected elements in southwest Michigan mosses as measured by PIXE analysis with values for mosses presented in portions of the world literature. The elements titanium, rubidium, strontium, bromine, and zirconium, measured by PIXE analysis and reported in Table 3, are not included in Table 4 because there were insufficient reports in the world literature to facilitate comparisons. Papers were selected in which the results are reported in ppm of dry weight. Inclusion of those reporting in percentage of ash weight was rejected since

TABLE 3. Distribution of 12 elements in 7 southwest Michigan mosses. All values are given in ppm dry weight. Uncertainty percentages are given in parentheses ( ). See text

	ATR	CLI	LEU	MNA	MNC
K	6094 (25)	5739 (25)	3202 (25)	10418 (25)	7668 (25)
Ca	7466 (25)	11598 (25)	4471 (25)	10423 (25)	12668 (25)
Ti	75 (21)	153 (21)	22 (52)	43 (24)	49 (23)
Mn	55 (25)	122 (25)	55 (26)	360 (25)	364 (25)
Fe	716 (15)	1884 (15)	891 (15)	484 (15)	645 (15)
Cu	7 (17)	9 (18)	8 (18)	6 (17)	8 (16)
Zn	20 (15)	49 (15)	25 (16)	43 (15)	64 (15)
Br	3 (35)	8 (32)	5 (34)	3 (34)	4 (32)
Rb	13 (16)	17 (17)	14 (18)	105 (15)	57 (15)
Sr	14 (16)	25 (17)	11 (20)	31 (15)	32 (15)
Zr	11 (20)	19 (21)	13 (23)	–	9 (22)
Pb	9 (25)	14 (27)	16 (25)	11 (24)	12 (24)

ash weight as a percentage of dry weight is known to vary considerably from species to species. Unless the exact ash weight percentage of dry weight is known for each species, it is not possible to convert reliably from percent ash weight to ppm of dry weight. In some cases, the averages reported in Table 4 were determined by the authors of the papers cited. In other cases, we calculated the averages from data reported for individual species in the papers cited.

As indicated in Table 4, the PIXE averages fell within the ranges of the values reported in the literature except for potassium. Potassium may read higher in southwest Michigan due to its liberal use in agricultural and garden fertilizers. Some of this fertilizer undoubtedly becomes airborne as fields and gardens are readied for planting. Small quantities of it may be settling out on southwest Michigan mosses. The high average calcium values in southwest Michigan mosses when compared with the average of reports in the literature may be the result of the widespread use of agricultural lime to adjust the usually acid soil pH and the use of calcium chloride as a dust retardant on unpaved roads.

The mean values of the world literature reports of manganese, iron, copper, zinc, and lead are all higher than the mean values for the seven species of southwest Michigan mosses. Of these, iron and lead show the greatest variance around the world. Groet (1976) attributed the high lead readings in New England to the density of vehicular traffic in the area. The same may apply to the lead concentrations reported by Steinnes (1980) and Thomas (1986) for highly populated and industrialized southern Norway and Sweden. The lead level in southwest Michigan mosses (13 ppm) indicates a low-level of lead pollution in the area.

The high concentration of iron reported by Rasmussen and Johnson (1976) in Denmark is the result of airborne particulates. Their moss samples came from the trunks of *Fraxinus* and *Fagus* trees. Since the mosses were not growing in soil, contamination from local soil particles is unlikely. The

for explanation. Abbreviations of moss species are those given in Table 1. Each sample (n = 1) contained at least 100 plants.

POL	THU	Range	Average	Average % Uncertainty
5294 (25)	5431 (25)	3202-10418	6264	25
2252 (25)	10146 (25)	2252-12668	8432	25
25 (41)	117 (21)	22-153	69	29
124 (25)	85 (25)	55-364	166	25
599 (15)	1101 (15)	484-1884	903	15
13 (16)	11 (16)	6-13	9	17
43 (15)	38 (15)	20-64	40	15
8 (32)	5 (32)	3-8	5	33
59 (15)	6 (19)	6-105	39	16
11 (20)	12 (17)	11-32	19	17
9 (28)	9 (21)	9-19	12	23
18 (23)	13 (22)	9-18	13	24

surprisingly high iron readings in Spitzbergen, a group of islands in the Arctic Ocean north of Norway, is attributed by Thomas (1986) to high iron levels in the geologic substrate coupled with a sparsity of vegetation. The likelihood of widespread distribution of particulates originating from the geologic substrate is increased when ground cover is sparse.

If the Denmark, southern Sweden, and Spitzbergen data are removed and the average iron concentration in mosses in the remaining four references is recalculated, the resultant average is 478 ppm. The higher average iron levels in southwest Michigan mosses (903 ppm) probably results from several factors. While this area does not have sparse vegetation as is the case in Spitzbergen, it does have widespread agriculture resulting in much cleared land from which airborne particulates could be locally derived. On the other hand, the area is about 100 miles downwind from the large iron and steel plants of the Gary-Hammond area of Indiana at the southern tip of Lake Michigan. The prevailing wind during the growing season is from the southwest and during the winter from the west and northwest (Eichenlaub et al. 1990). These winds probably play a significant role in delivering particulates to southwest Michigan. In addition to airborne particulates originating in the Gary-Hammond-Chicago area, a component of the comparatively high iron readings in southwest Michigan mosses is likely related to dust derived from the shipment of taconite ore on Lake Michigan which lies directly to the west of the study area.

Table 4 compares the concentrations of elements in mosses from areas of relatively low levels of atmospheric pollution with concentrations of the same elements in mosses from areas of moderate to high levels of atmospheric pollution. The concentrations of potassium, calcium, and copper are quite similar in both types of areas. The concentrations of manganese, iron, zinc, and lead, on the other hand, are substantially higher in the more polluted areas. Set against this backdrop, the comparatively low levels of manganese, iron, zinc, and lead in southwest Michigan mosses are likely the

TABLE 4. Comparison of average concentrations of selected elements in southwest Michigan mosses as measured by proton induced x-ray emission (PIXE) analysis with values for mosses derived from selected literature stratified by probable pollution levels. All values are given in ppm dry weight.

Location	K	Ca	Mn	Fe	Cu	Zn	Pb	Reference
Areas of relatively low levels of atmospheric pollution.								
N. Alaska					22	62	10	Smith (1986)
N. Norway				350		31	10	Steinnes (1980)
Spitzbergen	3203	7088	69	1740	6	31	1	Thomas (1986)
Average where present	3203	7088	69	1045	14	41	7	
Areas of moderate to high levels of atmospheric pollution.								
Britain	3610	12090	720	200				Bates (1982)
Poland			178	613	10	73	18	Kabata-Pendias & Pendias (1984)
Japan	2887	14590						Nagano (1972)
Denmark	5000	3000	165	2250	10	95	50	Rasmussen & Johnson (1976)
NE U.S.A.					11	64	141	Groet (1976)
S. Norway				750	15	72	107	Steinnes (1980)
S. Sweden	3784	1757	295	3215	18	97	72	Thomas (1986)
Average where present	3820	7859	340	1406	13	80	78	
Comparison of ranges and averages								
Range - All references	2887-5000	7571-14590	69-720	200-3215	6-22	31-97	1-141	
Range - Southwest Michigan	3202-10418	2252-12668	55-364	484-1884	6-13	25-64	9-18	This study
Average of all references where present	3697	7705	285	1303	13	66	51	
Average of southwest Michigan where present	6264	8432	166	903	9	40	13	This study

result of lower regional air pollution than prevails elsewhere. Further studies are planned to measure the extent to which these elements, as indicators of regional air pollution, increase in the future.

SUMMARY

The elemental composition of southwest Michigan mosses was measured by proton induced x-ray emission (PIXE) analysis. This is the first application of the PIXE technology to bryophytes. The elemental composition varied considerably from one moss species to another. The average values for the seven species studied were compared with data derived from other analytical techniques in various parts of the world. Further studies are planned to determine if continuing input of particulate pollutants from the Gary-Hammond-Chicago area, which lies about 100 miles upwind from the study area, and the influence of the increasing industrialization of southwest Michigan will be reflected in the mineral composition of future samples of southwest Michigan mosses.

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REVIEW

WOMAN BOTANISTS OF OHIO BORN BEFORE 1900. By Ronald L. Stuckey. Available from the author at RLS Creations, P.O. Box 3010, Columbus, OH 43210. 1992. x + 67 pp. (paper). $11.50 postpaid.

We have yet another of Ron Stuckey's lavishly illustrated histories; it deserves a wide audience. The work is subtitled ". . . with Reference Calendars from 1776 to 2028." The subtitle alone indicates the eclectic nature of the book. What on earth are the calendars in there for? Perhaps to learn that if you save your 1993 calendar you can use it over in 1999? (Your 1992 calendar does not recur until 2020.) Or perhaps because the author became enamored of a calendar-generating computer program? (There are many, including a very complex macro in WordPerfect 5.1.)

None of the above. The calendars are simply the surfacing of the author's playful spirit, and an invitation to look at the numerous dates given for each of the women considered and see what day of the week a long ago event occurred. It's *fun*, and everyone should try it.

The format of much of the book is also unconventional and delightful: after a thoughtful foreword by Emanuel D. Rudolph, there follows a preface, then a table of contents, two pages of dedicatory remarks, calendrical explanation, and then the core of the work itself on page 1, which is the recto page. Thereafter, the verso pages continue the running text, while the recto pages are devoted to photographs of the women botanists, thumbnail biographies, calendars, and reproductions of botanical subjects associated with the woman. This pattern continues to the middle, and then the book takes on a more conventional format to the end. There are two appendices, which attempt to account for *all* Ohio female botanists born before 1900; some were illustrators, some librarians, most did not pursue botany as a lifetime occupation.

The production of the book is especially pleasing—the photographs are sharply reproduced, the typeface is large and clear, and the margins are generous; there are no detectable typos. Stuckey's history is exhaustive, of course, and in crystalline English. He has taken care not to oversell the botanical contributions of his subjects; by the same token, he never condescends to them, either.

In an extended treatment of the contributions of Clara G. Weishaupt, the author happily includes a photograph of her with Emanuel Rudolph, whose contributions to the history of women in Botany are well known, together with Ann (Waterman) Rudolph, fondly remembered by all for her grace and erudition.

It is fitting that this book should have been published as part of the Columbian Quincentenary commemoration at Ohio State University. The rôle of women in the development of botany is well served by local histories like this one.

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TRANSPLANT TECHNIQUES USING BRYOPHYTES TO ASSESS RIVER POLLUTION: A PRELIMINARY FEASIBILITY STUDY

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This paper examines the feasibility of using polyvinyl chloride (PVC) tubes and the movement of large moss-bearing boulders as techniques to assess changes in element concentration related to river pollution. While bryophytes and lichens have been used for over a century to assess air quality (Puckett 1988) and lichen transplants have been used extensively in recent years to monitor heavy metal pollution in and around industrial areas (Showman 1972, LeBlanc & Rao 1974, Garty & Fuchs 1981, Winner 1988), relatively little has been done in using mosses to assess pollution in aquatic systems. Empain (1988) described a technique for exposing moss samples to polluted mists below waterfalls but there has been little work done on the use of bryophyte transplants in assessing river pollution.

Since our purpose was to examine the feasibility of using PVC tubes and large boulders in transplant studies, we did not prepare fully controlled experiments nor did we prepare large numbers of transplants which would make possible statistical treatment of the data collected. Further studies will be necessary to determine if the changes in element concentration in mosses, when transplanted from relatively pristine river environments to relatively polluted ones, can be reliably replicated and used to measure seasonal fluctuations in these changes. Our more modest goal here is to demonstrate the feasibility of the techniques used and to invite other investigators to join us in their further development and use.

Several studies indicated that the techniques described herein might be feasible and useful. Whitton et al. (1982) demonstrated that mosses and liverworts have the ability to accumulate large quantities of metals. Say et al. (1981) demonstrated positive correlation of zinc concentration in water with the shoot tips of two species of mosses growing in zinc contaminated water. Mouvet (1985) reported on studies of the Bienne, Cance, and Fensch Rivers in France indicating a clear correlation of metal concentration in moss tissues with concentrations found in the water. These studies suggested that monitoring river pollution via bryophyte transplant techniques might be feasible.

MATERIALS AND METHODS

Field collections and transplants

Grimmia rivularis Brid., with the boulders on which it was growing, was collected in mid-August, 1988, from the presumably unpolluted waters of the Little South Branch of the Pere Marquette River. The boulders weighed approximately 18 kg (40 lbs) each. The collection site, in the northern part of the Lower Peninsula of Michigan, was in the center of the south side of Sec. 9, T16N, R12W, Home Township, Newaygo County. Half of the moss was removed from each boulder, packed in zip-lock freezer bags, dried, and held for analysis. The remaining growths and their attached boulders were packed in large plastic bags for transport. The boulders were placed in the Kalamazoo River the following day. The transplant site was North of the D Avenue bridge, approximately 10 km (6 mi) west of the city of Kalamazoo, in Sec. 2, T1S, R11W.

Conocephalum conicum (L.) Lindb. was collected in mid-August, 1988, from the presumably unpolluted bank of Whiskey Run Creek, in the southwestern part of the Lower Peninsula of Michigan. The collection site was approximately 18.5 km (11.5 mi) west of Kalamazoo and 4.8 km (3 mi) west of the Fish Hatchery on M-43, Van Buren County, in Sec. 14, T2S, R13W. Half of the sample was transplanted in the Kalamazoo River, north of the D Avenue bridge the following day. The other half of the sample was packed in zip-lock freezer bags, dried, and held for analysis. All samples included in the study were analyzed at the same time.

The transplant containers were made from 10.2 cm (4 in) diameter pieces of polyvinyl chloride (PVC) pipe, cut to 76.8 cm (30 in) in length and serrated 2.6 cm (1 in) up from the bottom. A series of 0.64 cm (0.25 in) holes was drilled 38 cm (15 in) from the bottom to allow absorption of water. Commercial grade sphagnum peat was used to fill the lower 61 cm (24 in) of the pipes. The uppermost 15.4 cm (6 in) was filled with soil from the collection site, topped by the transplanted *Conocephalum*. The tops of the containers were enclosed in a piece of clear plastic, supported by wood splints, and secured to the container with duct tape. The plastic was punctured with several holes to allow gaseous exchange.

Both the *Grimmia* and *Conocephalum* transplants were left in the river for 90 days and were harvested in November, 1988.

Sample preparation and analysis

Large substrate particles were removed from the plants, using tweezers and a camel's hair brush. The plants were then placed in distilled water for several hours to separate out smaller substrate particles. The samples were rinsed three times with distilled water and allowed to air dry for 48 hours, after which they were pulverized with a mortar and pestle. The samples were stored in screw-top polyurethane vials which had been washed in 1 molar nitric acid, rinsed several times with distilled water, and finally with deionized water.

Sample preparation for proton induced x-ray emission (PIXE) and the PIXE procedure follow Ehrle et al. (1992). Pristine and transplanted *Grimmia rivularis* and *Conocephalum conicum* samples, along with the associated parent soil, were analyzed. Samples of the sphagnum peat were also analyzed to insure that contamination was not introduced from this source.

RESULTS

The preliminary analysis of pristine and transplanted *Conocephalum* and *Grimmia* samples, along with their soils, are presented in Tables 1–4. All elements measured by the PIXE system increased in the *Conocephalum* samples after exposure to Kalamazoo River water except K and Zr (Table 1). The largest percent increases were recorded for Mn (298), Cu (288), and Pb (250). The *Grimmia* samples (Table 3) recorded increases in all elements

TABLE 1. Preliminary measurements of element concentrations in pristine and transplanted *Conocephalum conicum* samples. All values except percent change are given in ppm dry weight.

Element	*Pristine*	*Transplanted*	*Increase*	*% Change*
K	4463	2969	(1494)	− 33
Ca	10325	15153	4828	+ 47
Ti	422	615	193	+ 46
Mn	144	574	430	+298
Fe	1736	3233	1497	+ 86
Ni	9	23	14	+156
Cu	16	62	46	+288
Zn	106	202	96	+ 91
Pb	22	77	55	+250
Br	11	15	4	+ 36
Rb	22	25	4	+ 18
Sr	37	39	2	+ 1
Zr	56	29	(27)	− 48

TABLE 2. Preliminary measurements of element concentrations in pristine and transplanted *Conocephalum conicum* parent soil. All values except percent change are given in ppm dry weight.

Element	*Pristine*	*Transplanted*	*Increase*	*% Change*
K	5179	5783	604	+ 12
Ca	11160	22502	11342	+102
Ti	752	796	44	+ 6
Mn	252	402	150	+ 60
Fe	3737	4187	450	+ 12
Cu	8	22	14	+175
Zn	62	108	46	+ 74
Pb	46	89	43	+ 93
Br	21	22	1	+ 5
Rb	49	50	1	+ 2
Sr	88	162	74	+ 84
Zr	136	113	(23)	− 17

except K, Ni, and Sr. The largest percent increases in the *Grimmia* samples were of Pb (296), Fe (282), Zn (244), Zr (236), and Cu (193).

The *Conocephalum* parent soil (Table 2) recorded increases in all elements after exposure, indicating that the soil was not a source for the relatively high concentrations measured in the bryophytes after exposure. The largest percent increases in the soil after exposure were of Cu (175), Ca (102), Pb (93), and Sr (84). The *Grimmia* parent soil (Table 4), recorded increases in all elements except Mn, Rb, and Zr. The largest percent increases in the *Grimmia* parent soil were of Ca (382), Zn (217), and Pb (1,353).

The data in Table 5 indicate that Ca, Cu, Zn, and Pb increased in the sphagnum packing. They also increased in concentration in the soil and bryophyte plants. This could only have occurred if these elements were being absorbed by all three from the river water. The data also suggests that

TABLE 3. Preliminary measurements of element concentrations in pristine and transplanted *Grimmia rivularis* vegetation. All values except percent change are given in ppm dry weight.

Element	*Pristine*	*Transplanted*	*Increase*	*% Change*
K	2087	1690	(397)	− 19
Ca	26326	34623	8297	+ 32
Ti	171	402	231	+135
Mn	2464	5461	2997	+122
Fe	1067	4075	3008	+282
Ni	54	40	(14)	− 26
Cu	15	44	29	+193
Zn	77	265	188	+244
Pb	25	99	74	+296
Br	40	68	28	+ 70
Rb	0	67	67	
Sr	43	13	(30)	− 70
Zr	25	84	59	+236

TABLE 4. Preliminary measurements of element concentrations in pristine and transplanted *Grimmia rivularis* parent soil. All values except percent change are given in ppm dry weight.

Element	*Pristine*	*Transplanted*	*Increase*	*% Change*
K	3405	3670	265	+ 8
Ca	6309	30409	24100	+ 382
Ti	493	899	406	+ 82
Mn	776	674	(102)	− 13
Fe	2860	4126	1266	+ 44
Zn	30	95	65	+ 217
Pb	17	247	230	+1353
Br	9	11	2	+ 22
Rb	52	46	(6)	− 12
Sr	89	123	34	+ 38
Zr	529	415	(114)	− 22

TABLE 5. Preliminary measurements of element concentrations in pre- and post-exposure sphagnum peat. All values except percent change are given in ppm dry weight.

Element	*Pre-Exposure*	*Post-Exposure*	*Increase*	*% Change*
K	3663	6162	2499	+ 68
Ca	4546	17242	12696	+279
Ti	565	682	117	+ 21
Mn	71	125	54	+ 76
Fe	1580	620	(960)	− 61
Cu	6	9	3	+ 50
Zn	21	31	10	+ 48
Pb	14	19	5	+ 36
Br	10	10	0	0
Rb	31	33	2	+ 6
Sr	64	64	0	0
Zr	159	170	11	+ 7

K and Zr may have leached from the soil since the amounts in the soil are much greater than those in the sphagnum packing or the plants. Further research will be necessary to determine the direction of movement of Ti, Fe, Br, Rb, and Sr. The increase in concentrations of Ca, Cu, Mn, and Zn in the sphagnum packing make it clear that the sphagnum could not have been a source of contamination, at least not for these elements.

It must be emphasized that these results report preliminary data from the analysis of few pristine and transplanted samples to demonstrate the feasibility and usefulness of the techniques. Further study, more systematically replicated and with more complete controls, will be necessary before definitive statements can be made regarding the comparison of the pristine and polluted environments used in this feasibility study.

DISCUSSION

The Kalamazoo River crosses the Kalamazoo metropolitan area. It serves as a rainwater runoff channel, resulting in random fluctuation in river velocity and water level following precipitation and during spring thaws. In spite of these fluctuations, the PVC pipe system designed for sustained exposure to river water and the transplantation of large boulders to the river bed proved successful in sustaining their initial positions, indicating that these techniques may be useful in monitoring elemental contamination in similar river systems elsewhere.

The round structure of the PVC pipes reduced the force applied by the water to their surfaces. The length and diameter of the pipe can be adjusted to meet the depth and flow expectations of the river system being studied. If necessary, rope can be used to anchor the upper portions of the pipe to fallen logs or overhanging brush.

Previous experiments involving the transplantation of stones to polluted rivers proved unsuccessful due to high river velocities and the coating of the moss vegetation by suspended solids, rendering the stones impossible to see (Benson-Evans & Williams 1976). The boulders transplanted in the Kalamazoo River were heavily coated with suspended solids, making sample preparation more difficult, but the coating did not affect their initial positions or our ability to find and retrieve them at the end of the transplant period.

The only disadvantage listed in Mouvet's (1985) summary on the use of bryophytes as biomonitors was their sensitivity to the physical conditions of the parent medium, implying that failure in a transplantation experiment could be due to a disruption of the intimate relationship between the bryophytes and their parent medium. Transplantations based on PVC pipe and large boulders eliminate these difficulties.

The *Conocephalum* samples were transplanted along with 15 cm (6 in) of parent soil to insure that plant-substrate interfaces were not disrupted. Since the *Conocephalum* samples continued to grow in the river and were healthy and lush at the end of the transplant period, it is apparent that they

were provided with an adequate amount of parent soil and that the liverwort can survive in contaminated waters for extended periods of time.

The transplantation of large boulders, with moss still attached, removes the possibility of failure due to disrupted moss-substrate interfaces, provided the moss and boulder are not damaged during collection, transport, and transplantation. It is necessary for the boulders to be moved to their new location as soon as possible to insure that the moss arrives at its new location in a healthy condition.

Both bryophyte species were selected for study because of their abundance and the relative ease of identifying them. *Conocephalum conicum* is a large thalloid liverwort, growing mainly on the banks of streams in low moist areas, and is probably the most common thalloid liverwort in the state (Steere 1964). The thalli are usually about 1.25 cm (0.5 in) wide and up to 5 cm (2 in) long. They branch dichotomously and have diamond-shaped markings surrounding white pores on their upper surfaces. *Grimmia rivularis* is characterized by its dark green to greenish-black color, its short upright growth habit, and its growth exclusively on rocks in wet places. Both species are ideally suited for the transplant techniques described above.

SUMMARY

Samples of *Conocephalum conicum* and *Grimmia rivularis* were successfully transplanted from relatively pristine environments into the Kalamazoo River. The transplants were successful due to the design of PVC tubes to facilitate *Conocephalum* transplants and the use of large boulders with intact populations of *Grimmia*. The mineral element composition of the bryophytes was examined prior to transplantation and after 90 days of exposure to Kalamazoo River water. Initial data indicate large increases in the concentrations of several elements as a result of the exposure.

Further studies are needed to replicate these results and to measure their seasonal periodicity. The results obtained to date, however, indicate that the use of PVC tubes and the movement of large boulders with intact moss populations are feasible and useful techniques to facilitate monitoring river pollution by means of bryophyte transplants. Further studies with more complete controls and systematic replications are planned to demonstrate further the usefulness of these techniques.

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MICHIGAN PLANTS IN PRINT

New Literature Relating to Michigan Botany

Continued from this journal 29: 111 (1990). For description of this series, see 26: 174 (1987). Your compiler has fallen far behind, but we continue the goal of eventually listing all new publications (since 1962) citing or based upon Michigan plants.

—Edward G. Voss

A. MAPS, SOILS, GEOLOGY, CLIMATE, GENERAL

(U. S. Department of Agriculture, Soil Conservation Service). Soil surveys for Barry, Cass, Cheboygan, Houghton, and Ogemaw counties have been distributed since our previous listing in May 1990. These all include complete aerial photographic coverage with boundaries of soil types overprinted. Such surveys are very useful in planning or interpreting field work. Michigan surveys are available from Soil Conservation Service, USDA, 1405 S. Harrison Rd., Room 101, East Lansing, Michigan 48823.

(U. S. Geological Survey). Since the previous mention of topographic maps (May 1990), 16 brand new and 13 revised topographic maps have been issued for Michigan (through 1991). All are 7 1/2-minute quadrangles and represent Lower Peninsula areas from (alphabetically) Adair to West Branch and (geographically) from Galesburg to Oscoda. Space forbids listing all. In addition, a revised 1:250,000 map for the 30 × 60 minute area named Traverse City has been issued.

D. HISTORY, BIOGRAPHY, EXPLORATION

Anderson, William R. 1991. Warren H. Wagner, Jr.-winner of the 1990 Asa Gray Award. Syst. Bot. 16: 1–2. [Delightful sketch of distinguished University of Michigan botany professor (and active MBC member) on occasion of his award from the American Society of Plant Taxonomists.]

Buck, William R. 1989. William Campbell Steere (1907–1989). Bryologist 92: 414–419. [Biographical sketch from birth and education in Michigan, faculty role from instructor to department chairman at University of Michigan to dean at Stanford, and final career at the New York Botanical Garden, with list of plants named for Steere and supplement to his bibliography.]

Crovello, Theodore J. 1978. Julius A. Nieuwland, C.S.C., 1878–1936. Amer. Midl. Nat. 100: 258–260. [Sketch, on centennial of his birth, of Belgian-born priest and University of Notre Dame professor, whose active botanical field work included considerable collecting in southwestern Michigan.]

Dolan, Rebecca W. 1991. The Friesner Herbarium (BUT) of Butler University. Brittonia 43: 54–56. [Notes inclusion of Potzger's collections from Mackinac and adjacent islands and, among exchanges received, Michigan material of H. A. Gleason.]

Goode, Jeanne. 1989. The Yunckers of Greencastle. Brittonia 41: 193–210. [This biographical account opens a Festschrift number of Brittonia honoring the late Truman G. Yuncker and his wife, both natives of Michigan. He graduated in 1914 from what is now Michigan State University and collected in the state during his youth and some later summers, although his graduate training and professional life were outside of Michigan.]

Mickel, John T., & W. H. Wagner, Jr. 1991. Joseph M. Beitel (1952–1991). Brittonia 43: 123–125. [Appreciative sketch of the life of former University of Michigan graduate student, known in Michigan (and elsewhere) for his work on *Lycopodium,* enthusiastic lectures and field trips in this state and beyond, summer classes at The Leelanau Center for Education, and discovery of the Michigan monkey-flower garnishing his meal in a restaurant near the latter.]

Price, Michael G. 1982. The ferns of Steere and Harrington. Contr. Univ. Michigan Herb. 15: 197–204. [History of collections made abroad 1870–1875 by J. B. Steere and processed in Ann Arbor by Mark W. Harrington, both 1868 U-M graduates and resulting in the first substantial botanical paper associated with the University of Michigan, in 1875.]

Reese, William D. 1988. Ruth Schornherst Breen (1905–1987). Bryologist 91: 233–234. [Native of Michigan (PhD, U-M 1941), on faculty of Florida State University 1926–1965.]

Socolow, Arthur A. (ed.). 1988. The State Geological Surveys. A History. Assoc. Amer. State Geologists. 499 pp. $20.00 (ppd.) from Geological Survey of Alabama, Box 0, Tuscaloosa 35486. [A modern version of G. P. Merrill's detailed 1920 volume (U. S. Natl. Mus. Bull. 109), much sparser with information but of course more up-to-date. Michigan rates 10 pages (including a full-page portrait of Douglass Houghton)–compared with 81 in Merrill. The important biological work and publications of the surveys are almost totally ignored.]

Voss, E. G., & A. A. Reznicek. 1988 ["1987"]. Frederick Joseph Herrmann [sic] (1906–1987). Bryologist 90: 466–467. [Brief obituary notice of distinguished University of Michigan graduate, collector and author of Michigan plants (see this journal 27: 59–73 (1988) for fuller account). Consistent misspelling of his name was introduced editorially in this notice.]

Wynne, Michael J. 1991. Obituary. Prof. Dr. William Randolph Taylor 21 December 1895 – 11 November 1990. Bot. Marina 34: 63–67. [Biography and bibliography of noted algologist, associated with the University of Michigan since 1930.]

Wynne, Michael J. 1991. William Randolph Taylor (1895–1990). Taxon 40: 350–351. [A shorter sketch, without bibliography, by Taylor's successor at the University of Michigan.]

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THE SPREAD OF PUCCINELLIA DISTANS (REFLEXED SALTMARSH GRASS) IN MICHIGAN

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A chance collection of reflexed saltmarsh grass, *Puccinellia distans* (Jacq.) Parl., on the west side of Alpena in 1985 (Garlitz 1989) stimulated my interest in the distribution of this introduced European halophyte. During the last seven summers, *Puccinellia distans* was collected at forty-eight locations and observed at many others. *Puccinellia distans* is more easily seen than collected because its favored habitat is heavily salted expressway verges (parallel strips three meters wide adjacent to highways).

The taxonomy and common name follow Dore and McNeill (1980). A complete set of voucher specimens was deposited at MICH and thirty-two duplicates were deposited at MSC. Herbaria consulted for distributional data on *P. distans* were AUB, BLH, MICH, MSC, UMBS, and WUD (herbarium abbreviations follow Holmgren et al. (1990) except for mjo, the personal herbarium of Michael J. Oldham).

PUCCINELLIA DISTANS IN ADJACENT STATES/PROVINCES

An interesting history of *Puccinellia distans* in southern Ontario was provided by Dore and McNeill in *Grasses of Ontario* (1980):

> "*Puccinellia distans* was introduced around the beginning of the century to the southwestern counties [of Ontario], and became established as a weed along cinder roadways and in trampled salty ground around oil wells in Lambton County. The specimens distributed by Herriot from Galt (Cambridge), variously dated 1879, 1901, and 1910 may stem from what is possibly the original introduction."

As of 1980, Dore and McNeill had recorded *P. distans* from nine counties (16 collections) of southwestern Ontario.

The spread of *Puccinellia distans* in states adjacent to Michigan appears to be a recent phenomenon as seen from floras and papers from these states. Braun (1967) reported only one Ohio record (Butler County). Cusick (1982) reported the spread of *P. distans* across Ohio in the 1970's. By 1981, *P. distans* had been collected in thirty-five Ohio counties, almost all collections being made from interstate highway verges. Mohlenbrock (1972) reported *P. distans* from only one Illinois county (Cook). By 1979, Swink and Wilhelm (1979) reported that *P. distans* was spreading rapidly in the Chicago area and known from all of the eleven Illinois counties included in *Plants of the Chicago Region*. They also reported the spread of *P. distans*

into Lake, Laporte, and Porter counties of northwestern Indiana. Fassett (1951) in *Grasses of Wisconsin* reported only two collections (Onconto and Sheboygan counties). It is likely that more recent data will show *P. distans* widely distributed in Wisconsin.

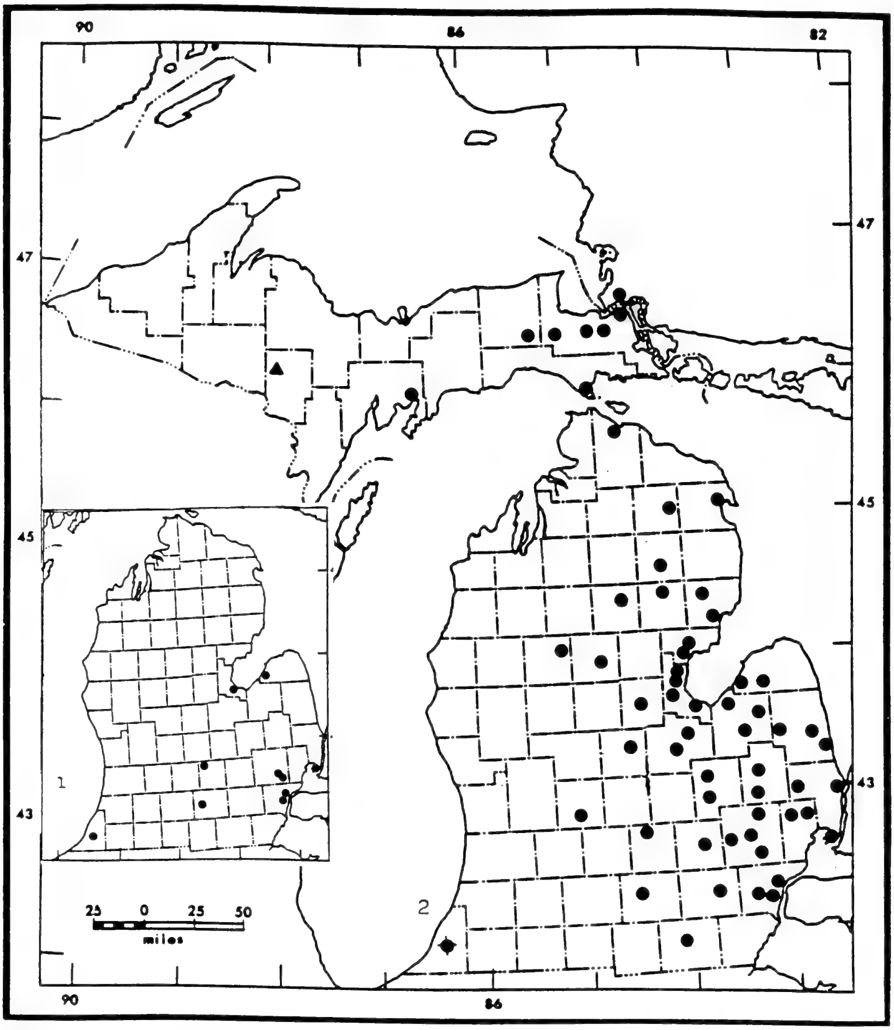
HISTORY OF *PUCCINELLIA DISTANS* IN MICHIGAN

Puccinellia distans was introduced early (prior to 1901) into Michigan. The first collections were made by C. A. Davis (s.n., MICH) and C. F. Wheeler (s.n., MSC), both in 1901 from a coal mine area where the ground was likely contaminated with brine pumped from the mine near Sebewaing in Huron County. G. M. Bradford (s.n., MSC) collected *P. distans* in nearby Bay County near Bay City in 1902. It was then fifty years before *P. distans* was collected in Wayne County near Detroit by N. W. Katz (*784*, BLH) in 1952. J. Hiltunen collected *P. distans* on Harsens Island, St. Clair County in 1960 (*2567*, WUD), and the following year (1961) added collections in Oakland and Wayne counties. Further collections were not added through 1965. Between 1965 and 1980, only four additional collections were made; S. Koch (*671*, MSC) found *P. distans* in Jackson County in 1967, S. N. Stephenson (s.n., MSC) added a collection near Lansing in 1970, N. W. Katz (s.n., BLH) found an additional collection for Oakland County, and a Berrien County collection was made during the 1970's and reported by Swink and Wilhelm (1979). One can see from Fig. 1 (inset map) that as recently as 1980, the distribution of *P. distans* in Michigan was poorly known.

DISCUSSION

After collecting *Puccinellia distans* near Alpena in 1985, I began to watch more closely for this grass in saline habitats and around major highway intersections and verges. In 1985, I was told by Dr. Anton Reznicek of The University of Michigan Herbarium that *P. distans* was spreading rapidly throughout Michigan and, in his opinion, would be in every county of Michigan within a decade. I think Dr. Reznicek is quite correct; *P. distans* could probably be found in every county of Michigan. As of 1980, *P. distans* had been collected in only eight counties (ten collections). Since 1985, I have collected *P. distans* forty-eight times in twenty-nine counties and at Sault Ste. Marie, Ontario. Of these twenty-nine counties, twenty-five represented new county records. As of July, 1991, *P. distans* has been collected in thirty-four Michigan counties (fifty-eight collections).

The following specimen list includes twenty-five counties where my collection was the first and includes only the earliest collection from each county.



FIGURES 1-2. 1. Distribution of *Puccinellia distans* in Michigan through 1980. All Upper Peninsula collections were made after 1981. 2. The distribution of *Puccinellia distans* in Michigan through 1991. Berrien County (✦) collection from Swink and Wilhelm (1979). Dickinson County report (▲) from A. A. Reznicek (pers. comm.). Map courtesy of J. H. Beaman.

CANADA. **ONTARIO**: Algoma District, E side of 17-N, N side of Sault Ste. Marie, 25 Jun 1989, *Garlitz 2851* (MICH, MSC). UNITED STATES. **MICHIGAN**. ALPENA CO.: Alpena Twp., sterile ditch, E side of Bagley St. near Alpena County Road Commission, 10 Jun 1985, *Garlitz 1011* (MICH, MSC). ARENAC CO.: Lincoln Twp., W side of US-23, Standish, 9 Jun 1990, *Garlitz 3147* (MICH, MSC). CHEBOYGAN CO.: Benton Twp., near salt storage barn on Lake St., N side of Cheboygan, 21 Aug 1988, *Garlitz 2596* (MICH, MSC). CHIPPEWA CO.: Soo Twp., at exit of I-75, 1/4 mi S of S

end of International Bridge, 24 Jun 1989, *Garlitz 2847* (MICH, MSC). CLARE CO.: Hayes Twp., N side of M-61 at Co. Rd. 130, 2 mi SE of Harrison, 5 Jun 1991, *Garlitz 3409* (MICH, MSC). GENESEE CO.: Vienna Twp., N side of M-57, 1/4 mi W of Clio, 23 Jun 1990, *Garlitz 3176* (MICH, MSC). GRATIOT CO.: Wheeler Twp., N side of M-46, E side of Breckenridge, 11 Jul 1990, *Garlitz 3262* (MICH, MSC). IONIA CO.: Orange Twp., corner of M-66 & I-96, 7 mi S of Ionia, 2 Aug 1990, *Garlitz 3331* (MICH, MSC). IOSCO CO.: Alabaster Twp., E side of US-23, 4 mi SW of Tawas City, 23 Jun 1990, *Garlitz 3173* (MICH, MSC). LAPEER CO.: Metamora Twp., corner of M-24 & Brauer Rd., 8 mi S of Lapeer, 23 Jun 1990, *Garlitz 3182* (MICH, MSC). LENAWEE CO.: Adrian Twp., W side of M-52, 4 mi N. of Adrian, 1 Aug 1990, *Garlitz 3306* (MICH). LIVINGSTON CO.: Hartland Twp., N side of M-59, 180 m W of US-23, 6 mi N of Brighton, 23 Jun 1990, *Garlitz 3178* (MICH, MSC). LUCE CO.: Pentland Twp., corner of Co. Rd. 393 & M-28, 8 mi SE of Newberry, 24 Jun 1989, *Garlitz 2850* (MICH). MACKINAW CO.: Moran Twp., at Ford-Mercury Sales parking lot, N side of US-2, 1 mi W of St. Ignace, 26 Jun 1989, *Garlitz 2859* (MICH, MSC). MACOMB CO.: Richmond Twp., N side of 32 Mile Rd., NE side of Richmond, 3 Jun 1991, *Garlitz 3404* (MICH). MIDLAND CO.: Jerome Twp., N side of Saginaw Rd., W edge of Sanford, 9 Jun 1990, *Garlitz 3164* (MICH, MSC). MONTMORENCY CO.: Hillman Twp., corner of M-32 & Co. Rd. 451, S side of Hillman, 11 Jul 1990, *Garlitz 3275* (MICH, MSC). OGEMAW CO.: Rose Twp., E side of M-33, 4 mi N of Rose City, 11 Jul 1990, *Garlitz 3276* (MICH, MSC). OSCEOLA CO.: Middle Branch Twp., corner of M-66 & M-61, 4 mi S of Marion, 5 Jun 1991, *Garlitz 3408* (MICH, MSC). OSCODA CO.: Mentor Twp., E side of M-33 at M-72, N side of Mio, 11 Jul 1990, *Garlitz 3274* (MICH, MSC). ROSCOMMON CO.: Markey Twp., W side of M-18, 5 mi S of Roscommon, 12 Jun 1991, *Garlitz 3417* (MICH). SAGINAW CO.: Buena Vista Twp., E side of M-13, 1 mi S of SE end of the Zilwaukee Bridge near Saginaw, 23 Jun 1990, *Garlitz 3175* (MICH, MSC). SANILAC CO.: Washington Twp., one block S of M-46, on SW side of Carsonville, 3 Jun 1991, *Garlitz 3399* (MICH). TUSCOLA CO.: Indianfields Twp., NE corner of M-24 & M-46, 5 mi S of Caro, 23 Jun 1990, *Garlitz 3188* (MICH, MSC). WASHTENAW CO.: Pittsfield Twp., NW exit of US-23 to Washtenaw Ave., SE side of Ann Arbor, 5 Jun 1991, *Garlitz 3407* (MICH).

Heavy salting and frequent winter plowing of major freeways have created ideal conditions for the spread and survival of reflexed saltmarsh grass. Large stands are frequently seen close to the highway edge where little else grows in the saline soil. *Puccinellia distans* flowers and sets seed early, often before June 20, so much escapes mowing. It is a perennial and often regrows after mowing. Large stands occur around urban areas in southeastern Michigan along expressways and in low depressions where saltpan-like conditions develop (pers. observed at Ann Arbor, Bay City, Detroit, Flint, Pontiac, and Saginaw). *Puccinellia distans* is frequently seen at low ends of entrance and exit ramps of expressways. I have also found this grass several times at city salt storage barns or where salt-spreading trucks are parked (Alpena, *Garlitz 1011*; Cheboygan, *Garlitz 2596*, and Osceola County, *Garlitz 3408*).

As noted from its distribution through 1991 (Fig. 2.), *Puccinellia distans* has now been collected from southern Michigan to Sault Ste. Marie, Ontario. The western half of the state is probably under-collected. I am quite sure that *P. distans* would be easily found there if looked for in saline habitats between June 10 and July 10 (before highway verge mowing gets underway).

Two additional species of halophytes in the genus *Puccinellia* should be mentioned as they are likely to be found in Michigan. *Puccinellia fascicu-*

lata (Torr.) Bickn. is a halophyte of eastern marshes of the Atlantic shore from Nova Scotia to Virginia and is now being found inland. It was collected by M. J. Oldham (*8826*, [DAO], MICH, [UWO, mjo]) in September of 1988 near a service center exit from Highway 401 ca. 15 km SW of London, Ontario.

Puccinellia nuttalliana (Schultes) A. Hitchc. (*P. airoides* (Nutt.) S. Watson and J. Coulter) is a western halophyte found from Wisconsin westward and is common in western states from the Canadian border to Mexico (Hitchcock 1950). More recently, it was stated by Holmgren and Holmgren (1977) that *P. nuttalliana* is found in:

> "moist, usually alkaline soils, sometimes in standing water: Alaska to Greenl., s. to Calif. n. half of Nevada and Utah, e. across Colo. and Kansas to Mich. and adventive to New England."

The basis for this Michigan report is not known, and thus far, no voucher sheet of *P. nuttalliana* collected in Michigan has been seen. Dr. Patricia Holmgren of the New York Botanical Garden (pers. comm.) was not able to shed any light on this reference and found no specimens of *P. nuttalliana* from Michigan at NY. Voss (1972) found no material of *P. nuttalliana* from Michigan prior to his publication.

Puccinellia nuttalliana should be looked for in Michigan, as Fassett (1951) reported this grass from collections in Douglas, Marquette, and Milwaukee counties in Wisconsin. *Puccinellia nuttalliana* was reported by Dore and McNeill (1980) as introduced as far east as Longlac, Thunder Bay District north of Lake Superior. More recently, *P. nuttalliana* has been found by C. E. Garton (*16548*, MICH) at Thunder Bay, Ontario on July 7, 1975 and by M. J. Oldham (*7546*, [DAO], MICH, [mjo]) on July 8, 1987 in a low area at the Iona Road exit off Highway 401 southwest of London in Elgin County, Ontario. It is possible that *P. nuttalliana* might be introduced into Michigan from either east or west (or both) and might at any time be found as part of our adventive flora. *Puccinellia nuttalliana* is larger but more delicate than *P. distans* and the lower branches of the panicle are less likely to be reflexed as they usually are in *P. distans*. The differences between these two species are nicely illustrated in Holmgren and Holmgren (1977).

ACKNOWLEDGMENTS

I wish to thank J. H. Beaman (MSC), A. A. Reznicek (MICH), E. G. Voss (UMBS), and J. R. Wells (BLH) for assistance in examining herbarium records and material. I express special thanks to Dr. Voss for help with records from WUD and to Dr. Reznicek for help on an early draft of this paper, for verification of specimens, and for help in locating Canadian records on *Puccinellia fasciculata* and *P. nuttalliana*. R. K. Rabeler has assisted me greatly in preparing the paper for publication.

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ANNOUNCEMENT
PRAIRIE CONFERENCE PROCEEDINGS

The Proceedings of the Twelfth North American Prairie Conference have just been published. The table of contents includes 47 papers grouped by topic into eight categories, papers that were given at the meeting held at the University of Northern Iowa.

This volume is published by the University of Northern Iowa and may be ordered for $20, including postage. Please make checks payable to the University of Northern Iowa and send to the following address:

UNI Continuing Education, Proceedings of 12th North American Prairie Conference, University of Northern Iowa, Cedar Falls, IA 50614-0223

NEW STATIONS FOR CAREX OLIGOCARPA (CYPERACEAE) IN PRINCE EDWARD COUNTY, ONTARIO

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Carex oligocarpa Schk. ex Willd. (few-flowered sedge) is a sedge primarily of dry woods and banks that is rare in Canada and Ontario and has a high Canadian Priority Rating 2 (Argus & Pryer 1990). Ball and White (1982) have indicated that its distribution encompasses the northern two-thirds of the eastern United States, and enters Canada only in the five counties and regional municipalities that border on the northern shores of Lakes Erie and Ontario: Essex, Elgin, Niagara, Northumberland, and Prince Edward. Only one of these stations was indicated as being recent (Point Pelee), while the remaining four were collected prior to 1925.

Since 1982 several additional stations for this species have been discovered in Ontario and adjacent Quebec. This paper briefly discusses the stations for Prince Edward County and comments upon new stations elsewhere.

The first Prince Edward County collection of this species was made in 1878 by John Macoun from 'Drybanks' in the vicinity of Picton. No other records had been discovered since that time either in that county (Whitcombe et al. 1973) or from elsewhere in the Kingston region (Beschel et al. 1970). However, in 1986 and 1987, studies conducted in Prince Edward County for the Areas of Natural and Scientific Interest (ANSI) program of the Ontario Ministry of Natural Resources by Ian D. Macdonald (1987), and independent studies by Michael J. Oldham and Donald A. Sutherland, resulted in the discovery of five new stations.

The habitats within Prince Edward County that were occupied by this sedge tended to be dry-mesic to mesic, deciduous woodlands with sugar maple, American beech, white ash, and shagbark or bitternut hickories (Fig. 1, stations 3, 5, 6), or dry to dry-mesic, successional, mixed, thickets of eastern red cedar, sugar maple, and white elm (stations 2, 4). The new sites were associated primarily with the limestone pavement, escarpment and valley landforms (stations 3, 4, 6) and, in one case, with the contact zone between the limestone and underlying Precambrian gneissic bedrocks (station 2). The populations tended to be local and sparse with only 1 to 5

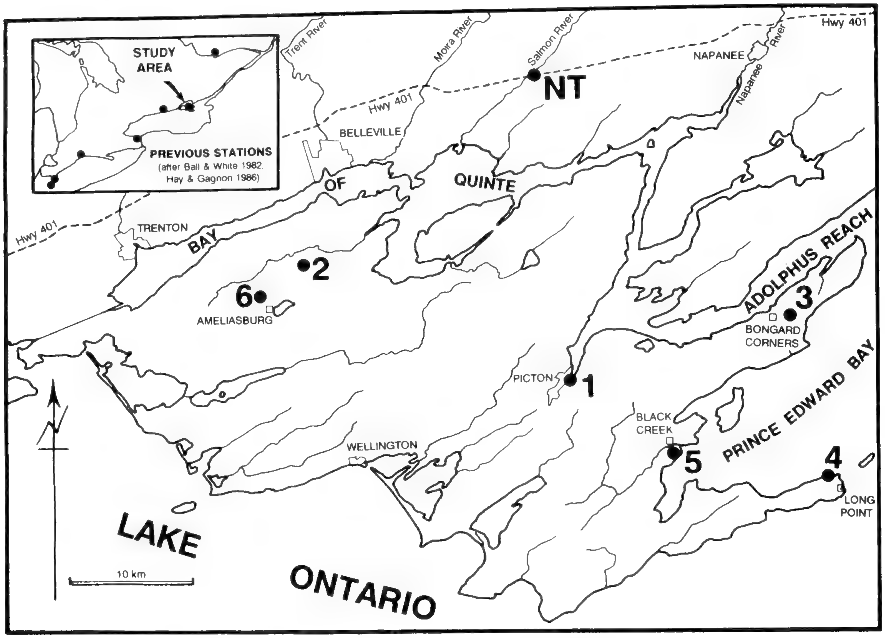

FIGURE 1: Prince Edward County stations for *Carex oligocarpa*.
6 Macoun, Macdonald, Oldham, Sutherland stations
NT Naczi & Tallent station (Hastings County)

plants in a 2 to 10 square meter area (stations 4, 6), but at one station (station 4), the population was relatively common with over 20 fruiting plants.

Carex oligocarpa also has been recently discovered at several other stations in eastern Canada. Since 1982 it has been collected from several stations on Pelee Island (*Oldham 3751*, CAN, MICH, TRTE; *Reznicek 6313*, MICH), and in early 1987 R.F.C. Naczi and R. Tallent (*Naczi 1688*, MICH) discovered a small population in Hastings County at the Highway 401 crossing of the Salmon River (Reznicek, pers. comm., 1989). Additionally, D. Gagnon and Y. Bergeron (*S4M-12*, MT) collected it in 1978 from Quebec in the Ottawa Valley within 15 km of the Ontario border (Hay & Gagnon 1986).

As a group, sedges generally have tended to be overlooked in many field studies. *Carex oligocarpa* is in the section *Oligocarpae* (J. Carey) Mackenzie (Voss 1972), and can be mistaken for the other member of this section which occurs in Canada, *Carex hitchcockiana* Dewey (Hitchcock's sedge), which is generally more common and with which it may occur. (Two other recently described members of this section occur in the southeastern United States, but not in Canada (Naczi 1989).) *Carex oligocarpa* is readily distinguished by the lack of hairs on its sheaths, smaller perigynia (to 4 mm long), reddish bases, straight-beaked achenes, and generally smaller size. As well,

it could be mistaken initially for members of the allied sections *Laxiflorae* (Kunth) Mackenzie or *Griseae* (L. Bailey) Kuk. (Voss 1972), differing from the former in the presence of rough-awned pistillate scales, and from the latter in the presence of beaked and narrow-based perigynia.

The discovery of this rare species in four of the eleven potential Area of Natural and Scientific Interest (ANSI) upland sites that were examined in Prince Edward County and its appearance in surveys elsewhere may indicate that it is more widespread than formerly thought. Botanical searches for further stations of this rare species should be undertaken in those counties and regional municipalities bordering on Lakes Erie and Ontario, and probably even elsewhere in southern Ontario. The Quebec station lends hope for its discovery in the Ottawa–Carleton area.

ACKNOWLEDGMENTS

The authors thank Dr. P.W. Ball for confirming the determinations of this sedge, Dr. A.A. Reznicek for providing information on the Hastings County station, and the reviewers for their helpful comments.

DOCUMENTATION

Collection data for these stations (location, collection date, habitat and notes, collector and number, herbarium) are presented below, and Figure 1 indicates the locations for these new stations. These recent collections from Prince Edward County are housed at the following herbaria (herbarium abbreviations from Holmgren et al. 1990): CAN, DAO, MICH, QK, TRTE.

1 Picton, Drybanks; (no habitat data); 4 July 1878; *Macoun 2031 & 31551* (CAN).

2 Ameliasburgh Twp., 3 km NE of Ameliasburg, grid UD 3075/48845; at the contact of gneiss and limestone on gneissic outcrop, under dry grove of *Juniperus virginiana–Acer saccharum–Ulmus americana–Zanthoxylum americanum–Cornus foemina–Prunus virginiana*; with *Fragaria virginiana, Solidago canadensis, Hieracium piloselloides, Satureja vulgaris*; 20 plants in 2×6 m area, and 5 plants in 1 × 2 m area; 24 May 1986; *Macdonald 17262* (CAN, TRTE, QK).

3 North Marysburgh Twp., 1 km E of Bongard Corners; grid UD 3465/48800; on access road with local seepage on slope of limestone escarpment; under mesic forest of *Acer saccharum–Carya cordiformis–Fraxinus americana–Carya ovata*; 5 robust plants in 2 × 4 m area; 25 May 1986; *Macdonald 17294* (QK).

4 South Marysburgh Twp., Long Point, 0.8 km W of Point Traverse, grid UD 3495/48674; locally common in dry-mesic open woodland on shallow soil over limestone pavement with scattered thickets of *Zanthoxylum americanum*; 31 May 1986, *Sutherland 6976 & Oldham* (TRTE, CAN, DAO).

5 South Marysburgh Twp., McMahon Bluff, 0.8 km S of Black Creek, grid UD 3366/48691; a few clumps on dry-mesic slope dominated by *Juniperus virginiana*; 31 May 1986; *Oldham 6231 & Sutherland* (MICH).

6a Ameliasburgh Twp., 1 to 1.5 km NW of Ameliasburg, grid UD 3038/48820; limestone escarpment valley bottom wet-mesic forest of *Acer saccharum–Fagus grandifolia–Tsuga canadensis–Carya cordiformis*; with *Carex hitchcockiana*; 17 June 1987; *Macdonald 18582* (TRTE).

6b Ameliasburgh Twp., 1.5 km NW of Ameliasburg, grid UD 3040/48820; limestone

escarpment valley bottom and slope mesic forest of *Acer saccharum—Fagus grandifolia—Fraxinus americana—Carya cordiformis*; 17 June 1987; *Macdonald 18585* (QK).

6c Ameliasburgh Twp., 1.5 km NW of Ameliasburg, grid UD 3040/48820; locally common in dry-mesic woodland; 5 Sept 1987; *Oldham 7867 & Sutherland* (MICH).

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ANNOUNCEMENT
MICHIGAN NATURAL AREAS COUNCIL

The Michigan Natural Areas Council is looking for additional members. The MNAC arose from the Conservation Committee of the Southeastern Chapter of the Michigan Botanical Club over 40 years ago. Members of the group actively seek out choice natural areas and work with both public and private organizations to ensure the preservation of both scenic and scientifically valuable parcels.

The MNAC now schedules two meetings a year, a general Spring meeting and the Annual Meeting, as well as occasional field trips. The Annual Meeting will be held at 2 PM on 8 November 1992 at the Matthaei Botanical Gardens in Ann Arbor, Michigan. The featured speaker will be Russell J. Harding, Chief of the Parks Division, Michigan DNR.

Persons wishing to join the MNAC should send a check for $15 to cover annual dues to: Emily Nietering, Treasurer, 231 Nash Street, Dearborn, MI 48124.

ANNOUNCEMENT
THE BIG TREES OF MICHIGAN—A NEW SERIES

In response to concerns about the content of *THE MICHIGAN BOTANIST* that have been expressed by some members of the Board of Directors of the Michigan Botanical Club, an ad hoc committee was established by the Board to investigate possible sources and/or topics for articles that would appeal to the general membership. The committee consisted of Drs. Erich Steiner, Elwood Ehrle, and Richard Rabeler.

One idea that arose from the deliberations of the committee can now be announced. Beginning probably in the May issue, you can expect to see one (or more, depending on space limitations) article(s) describing one of the Big Trees of Michigan. Each article will occupy two pages and include a description of the species, the location of the tree, a description of the tree, and an illustration showing diagnostic features of the species and the range of the species in Michigan. The authors are planning a series of articles, one for each Big Tree. Two are now in the hands of the editors and more are expected.

The possibility of a series of short articles on Michigan botanists, both past and present, is also being explored. If anyone is willing to write such articles, PLEASE contact Dr. Ehrle (Dept. of Biological Sciences, Western Michigan University, Kalamazoo, MI 49008) who is overseeing the project.

Do you have ideas for other short features? Articles similar to the Nature Education features that formerly appeared in *THE MICHIGAN BOTANIST* would be welcome. Now if only someone would write them. . . .

—Richard K. Rabeler

ERRATUM

A transposition crept into the review of *Manual of Vascular Plants of Northeastern United States and Canada* that appeared in Vol. 30, no. 4. The parenthetical reference on p. 206, line 6, should read Art. 23.6d, not 26.3d.

CONTENTS

On the cover: *Hoarfrost on velvet-leaf* (Abutilon theophrasti)
Photographed by E. Horkaway

Vol. 31, No. 3

THE MICHIGAN BOTANIST

May, 1992

THE MICHIGAN BOTANIST (ISSN 0026-203X) is published four times per year (January, March, May, and October) by the Michigan Botanical Club, c/o Herbarium, North University Building, The University of Michigan, Ann Arbor, MI 48109-1057. Second-class postage paid at Ann Arbor, MI. POSTMASTER: Send address changes to *THE MICHIGAN BOTANIST*, c/o Herbarium, North University Building, The University of Michigan, Ann Arbor, MI 48109-1057.

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Address changes from Botanical Club members should be sent only to appropriate chapter officers. Address changes for *NON-MEMBER SUBSCRIBERS ONLY* should be sent to the Business and Circulation Manager.

Articles dealing with any phase of botany relating to the Great Lakes Region may be sent to the Co-editors. In preparing manuscripts, authors are requested to follow our style and the suggestions in "Information for Authors" (Vol. 28, p.43; Vol. 29, p.143).

THE MICHIGAN BOTANICAL CLUB

Membership in the Michigan Botanical Club is open to anyone interested in its aims: conservation of all native plants; education of the public to appreciate and preserve plant life; sponsorship of research and publication on the plant life of the State; sponsorship of legislation to promote the preservation of Michigan native flora; establishment suitable sanctuaries and natural areas; and cooperation in programs concerned with the wise use and conservation of all natural resources and scenic features.

Dues are modest, but vary slightly among the chapters and with different classes of membership. Persons desiring to become state members (not affiliated with a local chapter, for which contact persons are listed below), may send $13.00 ($25 for 2 years) dues to the Membership Chairperson listed below. In all cases, dues include a subscription to *THE MICHIGAN BOTANIST*. (Persons and institutions desiring to subscribe without becoming members should deal directly with the Business and Circulation Manager.)

CHECKLIST OF THE VASCULAR FLORA OF THE AUGUSTA FLOODPLAIN PRESERVE[1]

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INTRODUCTION

The goal of this study is to record the species and their distributions by habitat within the Augusta Floodplain Preserve. Since floodplain forest is rare in Michigan, and its floristic composition poorly understood, we have counted the species in the preserve and classified their occurrence in relation to community type and geographic location. Distributional data and community composition are contained in a longer report to The Nature Conservancy. We report here a species list for the vascular plants of the Augusta Floodplain Preserve, and following it a synoptic table (Table 3) of the vascular plant taxa treated in the checklist.

PROPERTY DESCRIPTION

The Augusta Floodplain Preserve is a 68-acre (27.5 ha) tract of land in section 9 of Charleston Township, Kalamazoo County, Michigan. The preserve is approximately one mile southwest of Augusta, between Highway M-96 and the Kalamazoo River. Although owned and administered by The Nature Conservancy, Michigan Chapter, at present there is no public access to the Augusta Floodplain Preserve by land. However, anyone wishing access may contact The Nature Conservancy.

The preserve is located at the center of a largely undisturbed, approximately 500-acre floodplain ecosystem adjoining and northwest of the Kalamazoo River. The adjacent uplands are of glacial origin; their highly permeable soils belong to the Oshtemo and Kalamazoo soil series. These uplands provide both runoff and groundwater discharge into the Augusta Floodplain wetlands. The floodplain was (by definition) formed by the river, and the soils are primarily of riparian alluvial origin. The river spills

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over its banks and floods low areas immediately adjacent to the river in periods of high water. However, in most of the floodplain, runoff and groundwater discharge from the surrounding hills appear to supply the bulk of the water in the preserve's wetlands.

The preserve, and surrounding wetlands, includes five community types, distinguishable on the basis of the underlying soil and the dominant species within them. The spatial sequence of these types is illustrated in Figure 1. Most distal to the river and at the foot of the uplands is a strip of Houghton muck on which is found a marsh, with areas of wet thicket, and an occasional *Quercus bicolor* (swamp white oak) and *Ulmus americana* (American elm). Throughout much of the marsh, the dominant groundcover is the sedge *Carex aquatilis*. In the small portion of the marsh within the preserve

1	2	3	4	5	6	7	8	9	10	11	12
A1									BD	BD	C
13	14	15	16	17	18	19	20	21	22	23	24
		EFG			F				G		A1
25	26	27	28	29	30	31	32	33	34	35	36
					A2					H	I

FIGURE 1. Straight Line Diagram of Habitats Along Transect (1 cm = 10 m). The surveyed transect along which most of the observations and collections in this study were made was divided into 36 stations. The diagram here assumes that stations are equidistant; but, in fact, the sum of the true distances between the stations comprising a single habitat are enclosed in parentheses in the notes following. Also enclosed in the parentheses is the length of transect that a given habitat occupies as a percentage of the total length.

A1 Floodplain Forest (Stations 1–9.7; 24–30. 250 m. 42% of transect). A1 is far from the river, less exposed to the direct action of flood waters, including the uprooting of trees and washing away of seedlings. A1 is therefore a more stable floodplain forest environment than A2.

A2 Floodplain Forest (Stations 30–35. 119 m. 20% of transect). At these stations, the river is actively flooding the land, cutting channels, depositing silts and debris. Compared to A1, there are fewer species of herbaceous plants, and fewer microhabitats, especially hummocks and logs, for the provision of a safe footing in a wet soil.

BD Thickets (Stations 9.7–10; 11–14.5. 38 m. 6% of transect).

C Marsh (Stations 10–11. 12 m. 2% of transect).

EFG Mesic Woodland (Forest) (Stations 14.5–23. 140 m. 23% of transect). Habitat variations over the surface of the Mesic Forest (MES) include the southern slope (E), rising from the Thickets to the mesic table, and open to more light than any other portion of MES, *Prunus serotina* being the tree characteristic of this area; F, the mesic woodland as such, is typified by beech-oak-ash-elm; G is part of MES; there is a dense stand of *Asimina triloba* as the transect moves off the mesic table; and here at this edge there are more coves, more moist woods, and a rich stand of *Carex albursina*.

H Levee (35.3 m. 6% of transect).

I River's Edge (1 m. .001% of transect).

boundaries, the dominant is instead *Carex lacustris*, with *C. aquatilis* confined to the edges; while in the thicket, bordering the marsh, *Cornus amomum*, *C. sericea*, and *Viburnum lentago* dominate the shrub story.

Toward the river from the marsh is a much more extensive area of Glendora soil of alluvial origin. This area is covered with swamp/floodplain forest with some attributes of two of Barnes and Wagner's (1981) forest community types: deciduous swamp, and river floodplain and bottomland. It has very low tree species diversity. In most parts of the floodplain forest, *Acer saccharinum* (silver maple) dominates, in some the dominant is *Fraxinus nigra* (black ash), while in the shrub story of the forest, *Lindera benzoin* (spicebush) is nearly universal in its abundance. This habitat extends all the way to the river, but not without interruption.

Rising up less than three meters from the surrounding floodplain forest are small "islands" of Oshtemo soil which are apparently just high enough that they have not been eroded by the river. These sites are covered with mesic forest of higher diversity, the major tree species being *Acer saccharum* (sugar maple), *Fagus grandifolia* (beech), *Quercus rubra* (red oak), *Fraxinus americana* (white ash), and *Carya cordiformis* (bitternut hickory), but the shrub story seems nearly empty of shrubs while the herbaceous groundcover, though varied, is less diverse than that of the floodplain forest. *Carex pensylvanica* is the decisive dominant. The understory is likewise diverse, but the overwhelming dominant is *C. pensylvanica*. A few ancient levees within the preserve, but off the transect of intensive study, share some species with the mesic islands and provide sites for other species (*Matteuccia struthiopteris, Dicentra cucullaria*, and *Epifagus virginiana*) not found in the mesic forest.

Adjacent to the river is a natural levee system of higher clay content than the adjoining Glendora soils. The woodland here is somewhat more open and more diverse than in the floodplain forest, but still *Acer saccharinum* (silver maple) prevails. Untreed openings occur, hosting dense stands of grasses, among them *Elymus riparius*, *E. virginicus*, *E. virginicus* × *riparius*, *Phalaris arundinacea*, and *Cinna arundinacea*, and of *Urtica dioica* var. *procera* and *Laportea canadensis*. But even here there is a variety of microhabitats: beneath a rotund fallen tree grow *Hepatica acutiloba* and *Coptis trifolia*.

The five habitats outlined above can be divided into a number of subhabitats based on slight elevational changes and on species assemblages, and these are described briefly in Table 1. A more detailed description of our vegetation analysis and mapping has been filed with The Nature Conservancy.

DISCUSSION

The Augusta floodplain ecosystem has substantial plant species diversity. In our study of the vegetation of the 68-acre preserve, we identified 80 families, 178 genera, 287 species, and 7 varieties distributed among 4 divisions of plants. Of these plants, 20 are not native to Kalamazoo County,

TABLE 1. Habitats and Sub-Habitats

HABITAT	ABBREVIATION	SUB-HABITAT	DESCRIPTION
FLOODPLAIN FOREST	FPF	–	Riparian floodplain; a wet place dominated by trees.
		muck	Surface below water major part of the year.
		moist	Moist soil, but surface almost always above water; this includes the innumerable slightly raised hummocks and rotted logs found in the swamp.
		slough	Sloughs, some formed by river, some drain the marsh.
WET THICKET	THI	–	Dense canopy of shrubs.
MARSH	MAR	–	Wet, tree-less area; herbaceous canopy, generally dominated by sedges.
MESIC FOREST	MES	–	Mixed hardwood forest on medium dry sandy loam.
		mesic	Flattish central portion of the mesic forest "island".
		edge	On the southern slope or edge of the mesic forest.
		weed patch	Weedy patch on western side of mesic "island".
LEVEE	LEV	–	Elevated natural levees adjacent to the river; including the river's edge.

and of these 17 are alien to North America. *Dryopteris celsa* and *Habenaria flava* var. *herbiola* are on the list of plants endangered or threatened in the state of Michigan. This relatively high count of species is due not so much to the luxuriance of plant life in the floodplain forest itself, as to the fact that four other habitats intersected the floodplain forest transect. As can be seen in the checklist, many of the species occur in only one habitat. There are few undisturbed sites in Michigan where such an assemblage of communities can be examined. Because of variation in soils, hydrological patterns, and plant communities, the preserve is a valuable site for the study of variation in wetland communities and the factors controlling them.

CATALOG OF VASCULAR PLANTS

This species list was compiled between June 1 and October 30, 1990. Additions to the list arising from a partial survey of the Spring flora in April–May 1991 are noted as ('91). During the study period, we surveyed the preserve at least every other week for previously unrecorded species. Voucher specimens were collected for all but a few species. The checklist is

TABLE 2. Terms for levels of abundance used in the checklist and their meaning. Abundance notations refer to a specific habitat with which the term is associated in the list. Thus, the abundance of species may differ in two or more habitats. If it does, then habitat abbreviations are listed and an abundance term listed for each. Abundance is described relative only to the life-form of the species being described. Therefore, both a tree and an herb might be listed as dominant within one same sub-habitat.

TERM	MEANING
dominant	often or always the dominant species in the habitat
abundant	abundant throughout habitat, but not usually dominant
plentiful	abundant only in certain parts of the habitat
common	common throughout the habitat, more sparse than abundant
frequent	frequent, but not so ubiquitous as "common"
infrequent	found in at least a few locations
isolated occurrence	only one plant or population in the habitat

"consolidated" in that we have added to our own observations and identifications the earlier work of Harvey Ballard. A "(2)" after a species name is a Harvey Ballard record; "(1)" is our own record, for which a voucher is available, but the location, while in the preserve, is off the transect line. The vouchers reside in the Kellogg Biological Station Herbarium (KBSMS). Although the entire preserve was surveyed, every effort was made to collect the vouchers along a permanently marked transect which starts at the western edge of Section 9 at the half-section point and runs due east to the river, covering a distance of 600.4 m (Fig. 1). Exact locations along the transect are noted on the voucher-sheet labels. The 394 collections are included in the KBSMS data base and can be accessed by contacting TONSOR@KBSMS.BITNET.

At the outset, it was decided to use Gleason and Cronquist (1963) as the standard reference for identifications, while at the same time using Voss (1972, 1985) for all specimens treated in his two volumes. This was a compromise: Gleason and Cronquist was out of print, while Voss was incomplete. The reader will not be surprised that other books were consulted, and, indeed, Fernald (1950) was a constant companion to the work of keying. However, Gleason and Cronquist, second edition (1991) is the sole standard reference for this paper, and to their scheme of nomenclature we have adhered.

KEY TO THE CHECKLIST

In the consolidated checklist, a series of words and abbreviations in parentheses generally follows the scientific name of each species. Sets are separated by semi-colons. Each set pertains to a habitat type in which the species occurs. The first entry within a set indicates, with a three-letter abbreviation in capital letters, (one of) the habitat(s) in which the species

TABLE 3 Summary of Vascular Plant Taxa Treated.*

	Family	Genera	Species	Variety	Not Native**	Endangered
EQUISETOPHYTA						
EQUISETACEAE	1	1	1	1	0	0
Subtotals	1	1	1	1	0	0
POLYPODIOPHYTA						
ADIANTACEAE	1	1	1	0	0	0
ASPLENIACEAE	1	5	6	1	0	1
ONOCLEACEAE	1	2	2	0	0	0
OPHIOGLOSSACEAE	1	1	3	0	0	0
OSMUNDACEAE	1	1	2	0	0	0
Subtotals	5	10	14	1	0	1
PINOPHYTA						
CUPRESSACEAE	1	1	1	0	0	0
Subtotals	1	1	1	0	0	0
MAGNOLIOPHYTA						
ACERACEAE	1	1	3	0	0	0
ACORACEAE	1	1	1	0	0	0
ALISMATACEAE	1	2	2	0	0	0
ANACARDIACEAE	1	1	1	0	0	0
ANNONACEAE	1	1	1	0	0	0
APIACEAE	1	7	9	0	0	0
AQUIFOLIACEAE	1	1	1	0	0	0
ARACEAE	1	3	4	0	0	0
ARALIACEAE	1	2	2	0	0	0
ARISTOLOCHIACEAE	1	1	1	0	0	0
ASCLEPIADACEAE	1	1	2	0	0	0
ASTERACEAE	1	13	27	1	4	0
BALSAMINACEAE	1	1	1	0	0	0
BERBERIDACEAE	1	3	3	0	1	0
BETULACEAE	1	3	3	0	0	0
BORAGINACEAE	1	2	2	0	0	0
BRASSICACEAE	1	3	4	0	1	0
CAESALPINIACEAE	1	1	1	0	0	0
CAMPANULACEAE	1	2	4	0	0	0
CAPPARACEAE	1	1	1	0	1	0
CAPRIFOLIACEAE	1	1	3	0	0	0
CARYOPHYLLACEAE	1	1	1	0	1	0
CELASTRACEAE	1	1	2	0	0	0
CLUSIACEAE	1	2	3	0	0	0
CORNACEAE	1	1	4	0	0	0
CUCURBITACEAE	1	1	1	0	0	0
CUSCUTACEAE	1	1	1	0	0	0
CYPERACEAE	1	3	30	0	0	0
DIOSCOREACEAE	1	1	1	0	0	0
FABACEAE	1	6	6	0	2	0
FAGACEAE	1	2	7	0	0	0
FUMARIACEAE	1	1	1	0	0	0
GROSSULARIACEAE	1	1	1	0	0	0
IRIDACEAE	1	1	2	0	1	0
JUGLANDACEAE	1	2	2	0	0	0

* Format of Summary adapted from Kartesz and Kartesz (1980)
** Plants not native to the region of this study.

TABLE 3 Summary of Vascular Plant Taxa Treated* (Continued)

	Family	Genera	Species	Variety	Not Native**	Endangered
MAGNOLIOPHYTA (Cont.)						
LAMIACEAE	1	10	13	0	2	0
LAURACEAE	1	1	1	0	0	0
LILIACEAE	1	6	7	0	0	0
LYTHRACEAE	1	1	1	0	1	0
MENISPERMACEAE	1	1	1	0	0	0
MONOTROPACEAE	1	1	1	0	0	0
OLEACEAE	1	1	3	0	0	0
ONAGRACEAE	1	3	4	0	0	0
ORCHIDACEAE	1	1	1	1	0	1
OROBANCHACEAE	1	1	1	0	0	0
OXALIDACEAE	1	1	1	0	0	0
PAPAVERACEAE	1	1	1	0	0	0
PLANTAGINACEAE	1	1	1	0	0	0
PLATANACEAE	1	1	1	0	0	0
POACEAE	1	9	13	1	1	0
POLEMONIACEAE	1	1	1	0	0	0
POLYGONACEAE	1	2	3	0	1	0
PORTULACACEAE	1	1	1	0	0	0
PRIMULACEAE	1	1	4	0	1	0
RANUNCULACEAE	1	8	12	0	0	0
RHAMNACEAE	1	1	1	0	0	0
ROSACEAE	1	9	13	0	0	0
RUBIACEAE	1	3	10	0	0	0
RUTACEAE	1	1	1	0	0	0
SALICACEAE	1	1	3	0	0	0
SAURURACEAE	1	1	1	0	0	0
SAXIFRAGACEAE	1	3	3	0	0	0
SCROPHULARIACEAE	1	3	3	0	1	0
SMILACACEAE	1	1	3	0	0	0
SOLANACEAE	1	1	1	0	1	0
STAPHYLEACEAE	1	1	1	0	0	0
TILIACEAE	1	1	1	0	0	0
TYPHACEAE	1	1	1	0	0	0
ULMACEAE	1	2	4	0	0	0
URTICACEAE	1	4	3	1	0	0
VERBENACEAE	1	2	3	0	1	0
VIOLACEAE	1	2	8	1	0	0
VITACEAE	1	2	2	0	0	0
Subtotals	73	166	271	5	20	1
GRAND TOTAL	80	178	287	7	20	2

** Plants not native to the region of this study.

occurs. Words used to characterize sub-habitats are spelled out, as are terms characterizing the abundance of a plant. Table 1 lists the habitat abbreviations and sub-habitat terms. Table 2 lists the abundance terms. For example, *Carex intumescens* is followed by: (FPF, muck, slough, common), meaning that it is restricted to the floodplain forest, and within the forest it is restricted to the "muck" and "slough" sub-habitats, where it is common.

CHECKLIST OF VASCULAR PLANTS

EQUISETOPHYTA (HORSETAILS)

EQUISETACEAE (Horsetail Family)
Equisetum arvense L. (THI, isolated)
E. hyemale L. var. *affine* (Engelm.) A.A. Eaton (2)

POLYPODIOPHYTA (FERNS)

ADIANTACEAE (Maidenhair Fern Family)
Adiantum pedatum L. (FPF, moist, infrequent)

ASPLENIACEAE (Spleenwort Family)
Athyrium filix-femina (L.) Roth (1) (FPF, moist, isolated)
Cystopteris fragilis (L.) Bernh. (2)
Dryopteris celsa (W. Palmer) Small (2) [endangered species]
D. cristata (L.) A. Gray var. *cristata* (1) (FPF, moist, isolated)
D. carthusiana (Villars) H.P. Fuchs (FPF, moist, plentiful)
Polystichum acrostichoides (Michaux) Schott (MES, edge, plentiful)
Thelypteris palustris Schott (THI, plentiful-abundant; MAR, some-common)

ONOCLEACEAE (Sensitive Fern Family)
Matteuccia struthiopteris (L.) Todaro (1) (FPF, moist, isolated)
Onoclea sensibilis L. (FPF, muck, moist, plentiful; MAR, co-dominant)

OPHIOGLOSSACEAE (Adder's Tongue Family)
Botrychium dissectum Sprengel (1) (MES, isolated)
B. multifidum (S. Gmelin) Rupr. (MES, edge, isolated)
B. virginianum (L.) Sw. (MES, edge, isolated)

OSMUNDACEAE (Royal Fern Family)
Osmunda cinnamomea L. (1) (FPF, muck, plentiful)
O. regalis L. (FPF, muck, moist, plentiful-common)

PINOPHYTA (GYMNOSPERMS)

CUPRESSACEAE (Cypress Family)
Juniperus virginiana L. (MES, edge, isolated)

MAGNOLIOPHYTA (FLOWERING PLANTS)

ACERACEAE (Maple Family)
Acer rubrum L. (FPF, infrequent; MAR, infrequent)
A. saccharinum L. (FPF, dominant; MAR, isolated)
A. saccharum Marshall (MES, mesic, common)

ACORACEAE (Sweet Flag Family)
Acorus calamus L. (MAR, plentiful)

ALISMATACEAE (Water-plantain Family)
Alisma triviale Pursh (FPF, slough, infrequent)
Sagittaria latifolia Willd. (FPF, slough, infrequent; MAR, isolated)

ANACARDIACEAE (Cashew Family)
Toxicodendron radicans (L.) Kuntze (FPF, moist, abundant; LEV, abundant; THI, frequent)

FPF = Floodplain Forest; **THI** = Wet Thicket; **MAR** = Marsh; **MES** = Mesic Forest; **LEV** = Levee

ANNONACEAE (Custard-apple Family)
Asimina triloba (L.) Dunal (MES, edge, isolated)

APIACEAE (Carrot Family)
Chaerophyllum procumbens (L.) Crantz (2)
Cicuta bulbifera L. (MAR, isolated)
C. maculata L. (MAR, common)
Cryptotaenia canadensis (L.) DC. (FPF, moist, common)
Osmorhiza claytonii (Michaux) C.B. Clarke (MES, common)
O. longistylis (Torrey) DC. (FPF, moist, isolated)
Oxypolis rigidior (L.) Raf. (2)
Sanicula gregaria E. Bickn. (FPF, moist, common)
Sium suave Walter (MAR, isolated)

AQUIFOLIACEAE (Holly Family)
Ilex verticillata (L.) A. Gray (1) (FPF, slough, isolated)

ARACEAE (Arum Family)
Arisaema dracontium (L.) Schott (FPF, infrequent; LEV, infrequent)
A. triphyllum (L.) Schott (FPF, moist, infrequent; MES, infrequent)
Peltandra virginica (L.) Schott & Endl. (FPF, slough, plentiful)
Symplocarpus foetidus (L.) Nutt. (FPF, muck, slough, abundant; MAR, some)

ARALIACEAE (Ginseng Family)
Aralia nudicaulis L. (2)
Panax trifolium L. (FPF, moist, frequent) ('91)

ARISTOLOCHIACEAE (Birthwort Family)
Asarum canadense L. (FPF, frequent; THI, infrequent; LEV, infrequent)

ASCLEPIADACEAE (Milkweed Family)
Asclepias incarnata L. (MAR, frequent)
A. syriaca L. (2)

ASTERACEAE (Aster Family)
Ambrosia trifida L. (MES, weed patch, infrequent) [not native]
Antennaria plantaginifolia (L.) Richardson (MES, weed patch, isolated)
Arctium minus Schk. (MES, weed patch, isolated) [not native]
Aster cordifolius L. (THI, frequent)
A. firmus Nees (2)
Bidens connata Muhlenb. (THI, moist, infrequent)
B. coronata (L.) Britton (THI, infrequent)
Cirsium muticum Michaux (MES, weed patch, isolated)
Eupatorium maculatum L. (MAR, abundant; THI, infrequent)
E. perfoliatum L. (2)
E. purpureum L. (MAR, frequent)
E. rugosum Houtt. (FPF, moist, common)
Hieracium caespitosum Dumort. (MES, weed patch, isolated) [not native]
Rudbeckia laciniata L. (LEV, infrequent-frequent)
Senecio aureus L. (MAR, frequent; FPF, moist, edges of marsh, frequent)
S. aureus L. var. *intercursus* Fern. (FPF, moist, infrequent) ('91)
Solidago caesia L. (MES, infrequent)
S. canadensis L. (MAR, common)
S. flexicaulis L. (2)
S. gigantea Aiton (MAR, infrequent)

FPF = Floodplain Forest; **THI** = Wet Thicket; **MAR** = Marsh; **MES** = Mesic Forest; **LEV** = Levee

S. juncea Aiton (MAR, infrequent)
S. nemoralis Aiton (1) (MAR, infrequent)
S. ohioensis Riddell (2)
S. rugosa Miller (MAR, infrequent)
S. uliginosa Nutt. (2)
Taraxacum officinale Weber (FPF, moist, infrequent-frequent; MAR, isolated) [not native]
Vernonia gigantea (Walter) Trel. (MAR, plentiful)
V. noveboracensis (L.) Michaux (MAR, isolated)

BALSAMINACEAE (Touch-me-not Family)
Impatiens capensis Meerb. (FPF, muck, slough, moist, common; THI, frequent; MAR, some)

BERBERIDACEAE (Barberry Family)
Berberis thunbergii DC. (FPF, moist, isolated) [not native]
Caulophyllum thalictroides (L.) Michaux (MES, mesic, common)
Podophyllum peltatum L. (FPF, moist, frequent; MES, mesic, abundant)

BETULACEAE (Birch Family)
Betula alleghaniensis Britton (2) (FPF, moist, infrequent)
Carpinus caroliniana Walter (FPF, muck, moist, plentiful; LEV, plentiful)
Ostrya virginiana (Miller) K. Koch (1) (LEV, frequent)

BORAGINACEAE (Borage Family)
Hackelia virginiana (L.) I.M. Johnston (MES, weed patch, frequent)
Myosotis scorpioides L. (FPF, slough, plentiful)

BRASSICACEAE (Mustard Family)
Arabis laevigata (Muhlenb.) Poiret (MES, edge, infrequent)
Barbarea vulgaris R. Br. (LEV, frequent) [not native]
Cardamine concatenata (Michaux) O. Schwarz (MES; FPF; LEV) (1)
C. rhomboidea (Pers.) DC. (FPF, moist, plentiful) ('91)

CAESALPINIACEAE (Caesalpinia Family)
Cercis canadensis L. (LEV, infrequent-frequent)

CAMPANULACEAE (Bellflower Family)
Campanula americana L. (1) (LEV, frequent)
C. aparinoides Pursh (MAR, frequent)
Lobelia cardinalis L. (FPF, muck, moist, slough, infrequent; THI, frequent; MAR, isolated)
L. siphilitica L. (THI, frequent)

CAPPARACEAE (Caper Family)
Cleome serrulata Pursh (MES, weed patch, isolated) [not native]

CAPRIFOLIACEAE (Honeysuckle Family)
Viburnum acerifolium L. (MES, edge, isolated)
V. lentago L. (THI, abundant; MAR, infrequent)
V. prunifolium L. (MES, edge, frequent)

CARYOPHYLLACEAE (Pink Family)
Dianthus armeria L. (MES, weed patch, isolated) [not native]

FPF = Floodplain Forest; **THI** = Wet Thicket; **MAR** = Marsh; **MES** = Mesic Forest; **LEV** = Levee

CELASTRACEAE (Staff-tree Family)
Euonymus atropurpureus Jacq. (2)
E. obovatus Nutt. (MES, edge, frequent)

CLUSIACEAE (Mangosteen Family)
Hypericum punctatum Lam. (MES, weed patch, isolated)
H. pyramidatum Aiton (FPF, moist, infrequent; THI, frequent)
Triadenum virginicum (L.) Raf. (THI, infrequent)

CORNACEAE (Dogwood Family)
Cornus amomum Miller (THI, plentiful)
C. florida L. (MES, isolated)
C. sericea L. (THI, plentiful)
C. stricta Lam. (THI, plentiful)

CUCURBITACEAE (Gourd Family)
Echinocystis lobata (Michaux) Torrey & A. Gray (LEV, infrequent)

CUSCUTACEAE (Dodder Family)
Cuscuta gronovii Willd. (MAR, infrequent)

CYPERACEAE (Sedge Family)
Carex albursina Sheldon (MES, edge, plentiful)
C. alopecoidea Tuckerman (FPF, muck, infrequent)
C. amphibola Steudel (FPF, muck, moist, infrequent-frequent)
C. aquatilis Wahlenb. (MAR, frequent; THI, frequent)
C. blanda Dewey (FPF, muck, common; THI, infrequent)
C. bromoides Willd. (FPF, muck, slough, abundant)
C. cephalophora Muhlenb. (FPF, muck, infrequent-frequent)
C. convoluta Mackenzie (2)
C. crinita Lam. (FPF, muck, abundant)
C. cristatella Britton (FPF, muck, infrequent)
C. gracillima Schwein. (MES, edge, infrequent)
C. granularis Muhlenb. (FPF, muck, infrequent)
C. grayi J. Carey (FPF, muck, slough, abundant)
C. hirtifolia Mackenzie (2)
C. intumescens Rudge (FPF, muck, slough, common)
C. lacustris Willd. (THI, infrequent; MAR, dominant)
C. laxiculmis Schwein. (FPF, moist, frequent)
C. laxiflora Lam. (MAR, infrequent)
C. lupuliformis Sartwell (FPF, muck, infrequent)
C. lupulina Muhlenb. (FPF, muck, infrequent)
C. pensylvanica Lam. (MES, mesic, dominant)
C. retrorsa Schwein. (1) (FPF, edge of stream on N. border, plentiful)
C. rosea Schk. (FPF, moist, infrequent; MES, edge, infrequent-frequent)
C. rostrata Stokes (2)
C. stipata Muhlenb. (FPF, moist, common)
C. stricta Lam. (2)
C. vulpinoidea Michaux (2)
Cyperus odoratus L. (LEV, isolated)
Scirpus atrovirens Willd. (THI, plentiful)
S. cyperinus (L.) Kunth (THI, infrequent)

FPF = Floodplain Forest; **THI** = Wet Thicket; **MAR** = Marsh; **MES** = Mesic Forest; **LEV** = Levee

DIOSCOREACEAE (Yam Family)
Dioscorea villosa L. (FPF, muck, infrequent)

FABACEAE (Pea or Bean Family)
Amphicarpaea bracteata (L.) Fern. (FPF, muck, moist, common; THI, infrequent)
Apios americana Medikus (FPF, moist, common)
Desmodium nudiflorum (L.) DC. (2)
Gleditsia triacanthos L. (1) (LEV, isolated)
Lathyrus palustris L. (MAR, isolated) [not native]
Robinia pseudoacacia L. (LEV, isolated) [not native]

FAGACEAE (Beech Family)
Fagus grandifolia Ehrh. (MES, mesic, infrequent)
Quercus bicolor Willd. (FPF, muck, moist, frequent; THI, isolated; MAR, isolated)
Q. macrocarpa Michaux (2)
Q. muehlenbergii Engelm. (2)
Q. palustris Muenchh. (2)
Q. rubra L. (MES, mesic, infrequent-frequent)
Q. velutina Lam. (MES, mesic, infrequent-frequent)

FUMARIACEAE (Fumitory Family)
Dicentra cucullaria (L.) Bernh. (1) (FPF, but drier than usual, isolated occurrence on an old second levee)

GROSSULARIACEAE (Gooseberry Family)
Ribes americanum Miller (MES, isolated)

IRIDACEAE (Iris Family)
Iris pseudacorus L. (FPF, slough, frequent) [not native]
I. virginica L. (FPF, slough, plentiful; THI, isolated)

JUGLANDACEAE (Walnut Family)
Carya cordiformis (Wangenh.) K. Koch (MES, edge, frequent)
Juglans cinerea L. (2)

LAMIACEAE (Mint Family)
Blephilia hirsuta (Pursh) Benth. (FPF, moist, common; MES, weed patch, infrequent; LEV, common)
Glechoma hederacea L. (LEV, common) [not native]
Lycopus americanus Muhlenb. (FPF, muck, common)
L. uniflorus Michaux (FPF, moist, frequent)
L. virginicus L. (MAR, infrequent)
Mentha arvensis L. (THI, frequent)
Physostegia virginiana (L.) Benth. (FPF, muck, infrequent)
Prunella vulgaris L. (FPF, moist, infrequent; THI, frequent) [not native]
Pycnanthemum virginianum (L.) T. Durand & B.D. Jackson. (THI, infrequent)
Scutellaria galericulata L. (THI, frequent; MAR, frequent)
S. lateriflora L. (MAR, frequent)
Stachys tenuifolia Willd. (THI, infrequent)
Teucrium canadense L. (MAR, infrequent)

LAURACEAE (Laurel Family)
Lindera benzoin (L.) Blume (FPF, muck, moist, dominant; THI, isolated)

FPF = Floodplain Forest; **THI** = Wet Thicket; **MAR** = Marsh; **MES** = Mesic Forest; **LEV** = Levee

LILIACEAE (Lily Family)
Allium tricoccum Aiton (MES, edge, few)
Lilium michiganense Farw. (MES, mesic, frequent)
Maianthemum canadense Desf. (MES, mesic, edge, infrequent-frequent)
Polygonatum pubescens (Willd.) Pursh (FPF, moist, infrequent) ('91)
Smilacina racemosa (L.) Desf. (MES, infrequent-frequent)
S. stellata (L.) Desf. (MES, infrequent-frequent)
Trillium grandiflorum (Michaux) Salisb. (MES, edge, infrequent)

LYTHRACEAE (Loosestrife Family)
Lythrum salicaria L. (LEV, frequent) [not native]

MENISPERMACEAE (Moonseed Family)
Menispermum canadense L. (FPF, moist, infrequent; THI, infrequent; LEV)

MONOTROPACEAE (Indian Pipe Family)
Monotropa uniflora L. (1) (MES, frequent)

OLEACEAE (Olive Family)
Fraxinus americana L. (FPF, infrequent-frequent; MES, frequent; LEV, frequent)
F. nigra Marshall (FPF, muck, moist, abundant)
F. pennsylvanica Marshall (MES, frequent; FPF, infrequent)

ONAGRACEAE (Evening-primrose Family)
Circaea lutetiana L. (FPF, muck, moist, common)
Epilobium coloratum Biehler (THI, frequent)
E. leptophyllum Raf. (MAR, infrequent)
Ludwigia palustris (L.) Elliott (2)

ORCHIDACEAE (Orchid Family)
Habenaria flava (L.) R. Br. var. *herbiola* (R. Br.) O. Ames & Correll (1) (FPF, moist, isolated) [endangered species]
H. psycodes (L.) Sprengel (FPF, moist, isolated; MAR, isolated; THI, isolated)

OROBANCHACEAE (Broom-rape Family)
Epifagus virginiana (L.) Barton (1) (MES, mesic, frequent; LEV, infrequent)

OXALIDACEAE (Wood-sorrel Family)
Oxalis stricta L. (MES, weed patch, isolated)

PAPAVERACEAE (Poppy Family)
Sanguinaria canadensis L. (MES, plentiful)

PLANTAGINACEAE (Plantain Family)
Plantago rugelii Decne. (1) (FPF—dry light-gap site, moist, isolated)

PLATANACEAE (Plane-tree Family)
Platanus occidentalis L. (1) (FPF, moist, infrequent; LEV, infrequent)

POACEAE (Grass Family)
Brachyelytrum erectum (Schreber) P. Beauv. (2)
Cinna arundinacea L. (LEV, abundant)
Elymus hystrix L. (FPF, some; MES, mesic, common)
E. riparius Wieg. (LEV, plentiful)
E. virginicus L. (FPF, moist, frequent; LEV, abundant)
E. virginicus L. × *riparius* Wieg. (LEV, infrequent)
Glyceria striata (Lam.) A. Hitchc. (FPF, muck, moist, abundant)

FPF = Floodplain Forest; **THI** = Wet Thicket; **MAR** = Marsh; **MES** = Mesic Forest; **LEV** = Levee

Leersia virginica Willd. (THI, abundant; LEV, abundant)
Panicum clandestinum L. (MES, frequent)
P. latifolium L. (FPF, moist, isolated)
P. oligosanthes Schultes (MES, frequent)
Phalaris arundinacea L. (LEV, abundant)
Poa compressa L. (MES, edge, isolated) [not native]
Sphenopholis obtusata (Michaux) Scribner (THI, infrequent)

POLEMONIACEAE (Phlox Family)
Phlox divaricata L. (FPF, moist, plentiful; MES, edge, isolated)

POLYGONACEAE (Smartweed Family)
Polygonum virginianum L. (FPF, moist, plentiful)
Rumex crispus L. (MAR, frequent) [not native]
R. verticillatus L. (FPF, moist, plentiful)

PORTULACACEAE (Purslane Family)
Claytonia virginica L. (FPF, moist, frequent; MES, mesic, frequent)

PRIMULACEAE (Primrose Family)
Lysimachia ciliata L. (FPF, moist, common; THI, infrequent)
L. nummularia L. (FPF, muck, moist, slough, plentiful) [not native]
L. terrestris (L.) BSP. (MAR, infrequent)
L. thyrsiflora L. (FPF, muck, infrequent)

RANUNCULACEAE (Buttercup Family)
Actaea alba (L.) Miller (MES, common)
Anemone quinquefolia L. (MES, mesic, isolated) ('91)
A. virginiana L. (FPF, muck, plentiful) ('91)
Caltha palustris L. (FPF, muck, slough, plentiful)
Coptis trifolia (L.) Salisb. (FPF, moist, common-abundant)
Hepatica acutiloba DC. (MES, mesic, infrequent-frequent)
Isopyrum biternatum (Raf.) Torrey & A. Gray (FPF, moist, common) ('91)
Ranunculus abortivus L. (FPF, muck, common; THI, infrequent)
R. hispidus Michaux (2) (FPF, muck, common) ('91)
R. recurvatus Poiret (FPF, muck, infrequent)
Thalictrum dasycarpum Fischer & Avé-Lall. (FPF, muck, infrequent; LEV, infrequent)
T. dioicum L. (FPF, moist, frequent)

RHAMNACEAE (Buckthorn Family)
Rhamnus alnifolia L'Hér. (2)

ROSACEAE (Rose Family)
Agrimonia pubescens Wallr. (MES, weed patch, isolated)
Filipendula rubra (Hill) Robinson. (2)
Geum canadense Jacq. (FPF, muck, abundant)
G. macrophyllum Willd. (THI, frequent)
G. rivale L. (2)
Physocarpus opulifolius (L.) Maxim. (2)
Potentilla fruticosa L. (2)
Prunus serotina Ehrh. (MES, some-common)
Rosa palustris Marshall (THI, infrequent; MAR, infrequent)
Rubus allegheniensis Porter (MES, infrequent)
R. occidentalis L. (MES, weed patch, isolated)
R. pubescens Raf. (2)

FPF = Floodplain Forest; **THI** = Wet Thicket; **MAR** = Marsh; **MES** = Mesic Forest; **LEV** = Levee

Spiraea alba Duroi (THI, infrequent)

RUBIACEAE (Madder Family)
Cephalanthus occidentalis L. (FPF, muck, plentiful; THI, plentiful)
Galium aparine L. (THI, infrequent; MAR, infrequent)
G. asprellum Michaux (MAR, infrequent)
G. circaezans Michaux (MES, weed patch, edge, infrequent)
G. concinnum Torrey & A. Gray (2)
G. lanceolatum Torrey (2)
G. palustre L. (MAR, common)
G. trifidum L. (FPF, muck, common)
G. triflorum Michaux (FPF, muck, moist, infrequent-frequent)
Mitchella repens L. (2)

RUTACEAE (Rue Family)
Zanthoxylum americanum Miller (1) (LEV, infrequent)

SALICACEAE (Willow Family)
Salix humilis Marshall (2)
S. nigra Marshall (FPF, muck, moist, plentiful; THI, few; MAR, isolated)
S. sp. (THI, abundant)

SAURURACEAE (Lizard's-tail Family)
Saururus cernuus L. (FPF, slough, plentiful)

SAXIFRAGACEAE (Saxifrage Family)
Mitella diphylla L. (FPF, moist, frequent) ('91)
Penthorum sedoides L. (1) (FPF, moist, infrequent)
Saxifraga pensylvanica L. (THI, isolated)

SCROPHULARIACEAE (Figwort Family)
Chelone glabra L. (MES, weed patch, isolated)
Mimulus ringens L. (MAR, frequent; LEV, frequent)
Verbascum thapsus L. (MES, edge, isolated) [not native]

SMILACACEAE (Catbrier Family)
Smilax ecirrhata (Engelm.) S. Wats. (FPF, moist, isolated)
S. hispida Muhlenb. (MES, edge, frequent)
S. herbacea L. var. *lasioneura* (Small) Rydb. (2)

SOLANACEAE (Nightshade Family)
Solanum dulcamara L. (THI, frequent) [not native]

STAPHYLEACEAE (Bladder-nut Family)
Staphylea trifolia L. (MES, infrequent)

TILIACEAE (Linden Family)
Tilia americana L. (FPF, infrequent)

TYPHACEAE (Cat-tail Family)
Typha latifolia L. (MAR, isolated)

ULMACEAE (Elm Family)
Celtis occidentalis L. (1) (LEV, infrequent)
Ulmus americana L. (FPF, frequent; MAR, frequent)
U. rubra Muhlenb. (FPF, frequent)
U. thomasii Sarg. (FPF, infrequent; THI, infrequent)

FPF = Floodplain Forest; **THI** = Wet Thicket; **MAR** = Marsh; **MES** = Mesic Forest; **LEV** = Levee

URTICACEAE (Nettle Family)
Boehmeria cylindrica (L.) Sw. (THI, frequent)
Laportea canadensis (L.) Wedd. (FPF, muck, abundant; LEV, abundant)
Pilea pumila (L.) A. Gray. (FPF, muck, moist, abundant)
Urtica dioica L. var. *procera* (Muhlenb.) Wedd. (MAR, frequent)

VERBENACEAE (Vervain Family)
Phryma leptostachya L. (FPF, muck, infrequent; MES, edge, frequent) [not native]
Verbena hastata L. (FPF, moist, frequent; MAR, infrequent)
V. urticifolia L. (2)

VIOLACEAE (Violet Family)
Hybanthus concolor (T. Forster) Sprengel (2)
Viola affinis Le Conte (2)
V. conspersa Reichb. (FPF, moist, plentiful)
V. cucullata Aiton (2)
V. papilionacea Pursh (FPF, moist, common) ('91)
V. pubescens Aiton (2)
V. sororia Willd. (FPF, moist, plentiful)
V. striata Aiton (FPF, moist, plentiful)
V. striata × conspersa Reichb. (FPF, moist, frequent)

VITACEAE (Grape Family)
Parthenocissus quinquefolia (L.) Planchon (FPF, moist, abundant; LEV, abundant)
Vitis riparia Michaux (FPF, moist, infrequent; MES, edge, infrequent; LEV, plentiful)

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CAREX SECTION ACROCYSTIS (CYPERACEAE) IN OHIO

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ABSTRACT

Eight taxa of *Carex* section *Acrocystis* (= section *Montanae*) (Cyperaceae) occur in the Ohio flora. Members of this section are significant elements of the spring flora, but are overlooked because of their ephemeral nature and inconspicuous appearance. These carices grow in a variety of sunny woods and openings, often in sandy substrates. They are scarce in mesic situations. The state distribution and habitats of the eight Ohio taxa are described. *Carex albicans* var. *albicans*, *C. communis*, *C. pensylvanica*, *C. rugosperma*, and *C. umbellata* are distributed throughout Ohio. *Carex nigromarginata* is restricted to southernmost Ohio. *Carex albicans* var. *emmonsii* is a state-threatened taxon in northern Ohio. *Carex peckii* is presumed extirpated from the Ohio flora. A key is provided to these eight taxa plus two related species which may possibly be found in Ohio.

Carex section *Acrocystis* Dumort. (Cyperaceae) is a significant element of the spring flora of Ohio. This section includes some of the most common woodland sedges in the state. As a whole, however, this group has been overlooked and undercollected. The reasons for this neglect lie in the early blooming date, ephemeral nature of the fruiting culms, and inconspicuous appearance of these carices. Botanists have been known to walk over carpets of *C. umbellata* Schk. ex Willd. without seeing the plants.

Members of this section are among the earliest sedges to bloom and fruit in the Midwest. The perigynia of *Carex umbellata* and *C. nigromarginata* Schwein., for instance, are mature in mid- to late April in southern Ohio and in the first week of May in the north. I have seen the latter species in bloom in mid-March on a sheltered, south-facing slope in southern Ohio. The infructescences of some species, such as *C. umbellata*, are hidden in the leaf bases or are on extremely short peduncles. The perigynia often are quickly deciduous after maturation, reducing the time during which the species may be identified. Fruiting largely is finished by mid-May. After the perigynia fall, the leaves elongate to mature size, creating a sizable tuft of greenery. Thus, the plants are most conspicuous when past time for accurate identification.

While *Carex* section *Acrocystis* is distributed in all sections of Ohio, these sedges are most common on the Appalachian Plateau. Another significant center for these species is the Oak Openings just west of Toledo in northwestern Ohio. This small area consists of open oak woods and barrens on sand ridges which were the shorelines of post-glacial lakes (Gordon 1969, Moseley 1928). Members of *C.* section *Acrocystis* are rare in the Black Swamp counties of northwestern Ohio. The Black Swamp was a forest of

enormous extent which grew on the old beds of post-glacial lakes (Gordon 1969). This magnificent swamp was quickly cleared, drained, and converted into rich agricultural land. The rarity of these sedges in the Black Swamp reflects the lack of suitable natural habitat.

The habitat for *Carex* section *Acrocystis* species is difficult to describe since it is so generalized. These carices grow in a variety of well-drained sites in sun or semishade, typically in sand or in soil derived from sandstone. Common habitats include young upland woods, bluff tops, sand barrens, roadbanks, cemeteries, and churchyards. They are not common in mature or mesic habitats in Ohio, with the notable exception of *Carex communis* L. Bailey. The members of this section apparently resist cropping by animals. *Carex pensylvanica* Lam. in particular forms extensive colonies in grazed woodlands. Fruiting in *C.* section *Acrocystis* seems to be stimulated by fire. The plants often become robust following a fire, possibly as a result of fire-generated release of nutrients into the soil as well as the elimination of competing groundcover species.

This section of *Carex* traditionally has been known as sect. *Montanae* (Fries) J. Carey. The name *Acrocystis* has priority, however, and is used in recent treatments of the genus such as Chater (1980) and Tucker (1987). Taxonomy and nomenclature within the section are unstable. Therefore, this overview intentionally takes a broad approach to taxonomic status.

The following key includes the eight taxa of *C.* section *Acrocystis* confirmed in the Ohio flora, as well as two other species which possibly might occur in the state. Mature fruiting specimens with underground parts are most desirable for accurate identification. Individual plants do not always exhibit every character of a taxon; a range of specimens within a population should be examined for best results. Many key characters are adapted from Crins and Ball (1983) and Voss (1972).

KEY TO CAREX SECTION ACROCYSTIS IN OHIO

1. Fertile culms elongate, of uniform length, few or no inflorescences on very short peduncles or hidden at the base of the plant 2
    2. Body of perigynium, not including beak, orbicular to barely obovoid, ca as broad as long 3
        3. Widest leaves 3–5 mm broad (or more); bracts subtending middle and lowest pistillate spikelets with scarious lobes at base; rhizomes neither elongate nor brightly-colored . . . . C. communis
        3. Widest leaves 1.5–3 mm broad; bracts subtending middle and lowest pistillate spikelets without lobes; rhizomes elongate and often brightly-colored 4
            4. Beak of perigynium more than 1 mm long, half or more as long as body . . . . *C. lucorum* (not yet confirmed in Ohio)
            4. Beak of perigynium less than 1 mm long, less than half as long as body 5

5. Perigynium 1.2–1.5 mm wide; culm smooth below inflorescence; ventral face of sheath of upper cauline leaf usually deeply concave .... *C. pensylvanica*
5. Perigynium 1.5–2.2 mm wide; culm scabrous below inflorescence; ventral face of sheath of upper cauline leaf usually shallowly concave .... *C. heliophila* (not yet confirmed in Ohio)

2. Body of perigynium, not including beak, elliptic or oblong, definitely longer than wide 6
   6. Bodies of perigynia distinctly exceeding their scales .. *C. peckii*
   6. Bodies of perigynia ca as broad and long as their scales or shorter ... 7
      7. Culms firm and erect, usually surpassing the leaves; midrib of staminate scales weak or absent below tip ... *C. albicans* var. *albicans*
      7. Culms lax, loosely spreading or arching, usually shorter than the leaves; midrib of staminate scales prominent ... *C. albicans* var. *emmonsii*

1. Fertile culms of varying lengths, many inflorescences on very short peduncles or often hidden at the base of the plant 8
   8. Perigynia largely concealed by their scales; mature pistillate scales chestnut or purple with a prominent green midrib ... *C. nigromarginata*
   8. Perigynia wider and often longer than their scales, not concealed; mature pistillate scales green or brown, occasionally with a green midrib 9
      9. Perigynia 3–4 mm long, the beak 1.2–2 mm, half as long as the body or longer .... *C. rugosperma*
      9. Perigynia 2.5–3 mm long, the beak less than 1 mm long, ca 1/4 to 1/3 as long as body .... *C. umbellata*

The eight taxa discussed here are arranged alphabetically, followed by brief comments on geographic range in Ohio and elsewhere, habitats, taxonomy and nomenclature, and the status of the species in Ohio. Geographic information is taken primarily from Fernald (1950) and Gleason and Cronquist (1991). The distribution maps are based upon specimens in the following herbaria: BHO, BGSU, CINC, CLM, CM, DMNH, F, KE, MICH, MU, NY, OC, OS, and Marietta College, Marietta, Ohio. Herbarium abbreviations are those of Holmgren et al. (1981).

Carex albicans Willd. ex Sprengel var. *albicans* (Fig. 1)

Although this taxon occurs throughout Ohio, it is most common in the acidic soils of oak woods on the Appalachian Plateau and on the sand barrens of the Oak Openings. The habitat in Ohio, therefore, does not bear out the statement in Gleason and Cronquist (1963, p. 164) that this taxon grows "chiefly in calcareous districts." *Carex albicans* var. *albicans* is fre-

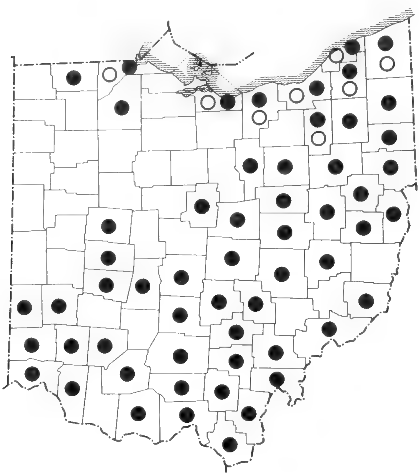

FIGURE 1. The Ohio distribution by county of *Carex albicans* var. *albicans* (solid circles) and *C. albicans* var. *emmonsii* (open circles).

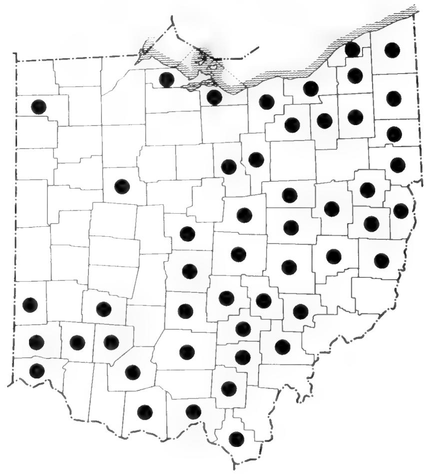

FIGURE 2. The Ohio distribution by county of *Carex communis.*

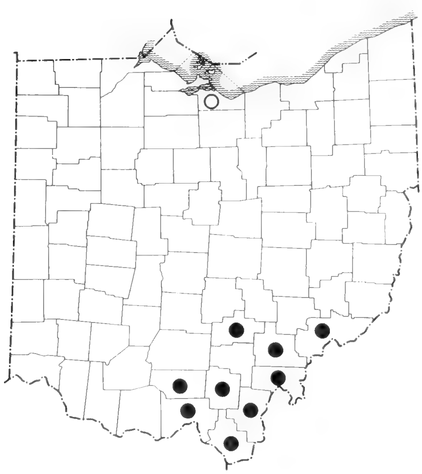

FIGURE 3. The Ohio distribution by county of *Carex nigromarginata* (solid circles) and *C. peckii* (open circle).

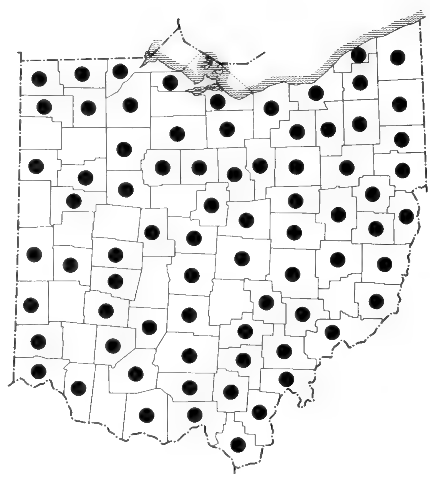

FIGURE 4. The Ohio distribution by county of *Carex pensylvanica*.

quent in eastern North America from Maine, southern Ontario, and Michigan, south to South Carolina and Oklahoma.

This taxon has long been known as *Carex artitecta* Mackenzie, a name in widespread usage (Braun 1967, Fernald 1950, Weishaupt 1971). It also has been treated as *Carex nigromarginata* Schwein. var. *muhlenbergii* (A. Gray)

Gleason (Gleason 1952). The concept followed here is that of Rettig (1988, 1989, 1990), a treatment likewise adopted in Gleason and Cronquist (1991).

Carex albicans Willd. ex Sprengel var. *emmonsii* (Dewey ex Torrey) Rettig (Fig. 1)

Emmons' sedge apparently is restricted in Ohio to a few northern counties. It usually is found in sandy situations such as the post-glacial beach ridges along eastern Lake Erie and in the open oak woods of the Oak Openings of northwest Ohio. A report from Athens County (Cusick & Silberhorn 1977) is an error based upon a misidentified *Carex albicans* var. *albicans*. Elsewhere, this taxon occurs on the Atlantic Coastal Plain from Nova Scotia to Florida and at scattered stations in the Great Lakes Region west to Illinois and Wisconsin.

Carex albicans var. *emmonsii* is listed as threatened in Ohio (Ohio Division of Natural Areas and Preserves, 1990). Only eight extant Ohio populations of Emmons' sedge presently are recorded in the ODNAP database. Perhaps the finest of these populations is in the Lou W. Campbell State Nature Preserve in Lucas County. Emmons' sedge apparently has benefited here from fires set over the past five years to manage for prairie species.

The two varieties of *Carex albicans* are weakly defined. Populations of these taxa usually can be determined by applying the characters in the key to a range of individuals. The taxonomic treatment followed here is that of Rettig (1988, 1989, 1990).

Carex communis L. Bailey (Fig. 2)

This species is frequent on the Appalachian Plateau in eastern Ohio with a few scattered stations elsewhere. *Carex communis* grows in more mesic habitats and tolerates more shading than other members of this section in Ohio. In the southern counties it typically occurs on mesic slopes and wooded stream terraces. In northern Ohio it is found on hemlock slopes and on hummocks in swamp forests. *Carex communis* is widespread in northeastern North America from Nova Scotia to Minnesota, south to South Carolina, Kentucky, and Arkansas.

Carex nigromarginata Schwein. (Fig. 3)

Black-margined sedge is confined in Ohio to the southernmost counties of the unglaciated Appalachian Plateau. It is locally common in oak-pine woods and on the tops of sandstone exposures. The distribution of this species is primarily from Louisiana to Florida, north along the coastal plain to Connecticut, and in the interior to Ohio and Missouri. A disjunct population recently was discovered along the north shore of Lake Erie in southern Ontario (Reznicek & Catling 1982). This species thus should be sought in sandy situations in northeastern Ohio. *Carex nigromarginata* is a beautiful sedge with brightly-colored scales of rich chestnut or purple with a green midrib.

Carex peckii Howe ex Peck (Fig. 3)

Peck's sedge was not listed for Ohio by Braun (1967) or Weishaupt (1971). Only two Ohio collections of *Carex peckii* so far have been located. The specimens were collected by E. L. Moseley in Ottawa County, apparently from the same site, in 1896 (BGSU) and 1912 (BGSU, CM). The labels simply read "Put-in-bay," the small town on South Bass Island in Lake Erie. Moseley (1899) included this species in his pioneering flora of the Erie Islands region as "*C. albicans*, Willd. */ Put-in-Bay, rare" (p. 51). The asterisk indicates that Moseley considered this species restricted in Ohio largely to that portion of the state. The name *Carex albicans* has been misapplied to more than one species, as discussed by Rettig (1989, 1990).

Searches for *Carex peckii* on South Bass Island over the past four years have been unsuccessful. Island habitats have been altered greatly since Moseley's time by recreational development and by the invasion of non-indigenous species. Peck's sedge is currently listed as presumed extirpated from Ohio (Ohio Division of Natural Areas and Preserves, 1990). This species might be rediscovered in the state, however, given its inconspicuous appearance and early blooming date.

Peck's sedge is distributed throughout northeastern North America south to New Jersey, Ohio, Michigan, and Minnesota. It grows in a variety of xeric to mesic calcareous sites, such as rock exposures and thin woods over limestone. This taxon also is known as *Carex nigromarginata* Schwein. var. *elliptica* (W. Boott) Gleason (Gleason 1952).

Carex pensylvanica Lam. (Fig. 4)

This is the commonest member of the section in Ohio; it undoubtedly grows in every county. It also is the easiest of our species to identify in vegetative condition because of its elongate rhizomes which often are bright wine-red in color. *Carex pensylvanica* occurs over a broad area of North America from southern Ontario and Manitoba, south to Georgia and Oklahoma. Crins and Ball (1983) provided a dot map for this species. It grows in sun to semishade in a variety of young woodland habitats. In grazed woodlots, *C. pensylvanica* forms extensive colonies due to its stoloniferous nature and resilience to cropping.

Two species closely related to *C. pensylvanica* which might be found in Ohio are discussed at the end of the alphabetical listing.

Carex rugosperma Mackenzie (Figs. 5 and 6)

This species occurs in exposed, xeric habitats in three somewhat disjunct sections of Ohio. In the northeastern quarter of the state, *Carex rugosperma* grows on bluff tops above rivers, on sandstone ledges, and on the summits of gravel moraines. It occurs in similar habitats in southeastern Ohio, as well as on sunny roadbanks. In northwestern Ohio, *Carex rugosperma* is locally common on sand barrens and in open oak woods. Moseley (1928), however, did not list it in his flora of the Oak Openings, an indication of how easily this species may be overlooked. In North America this

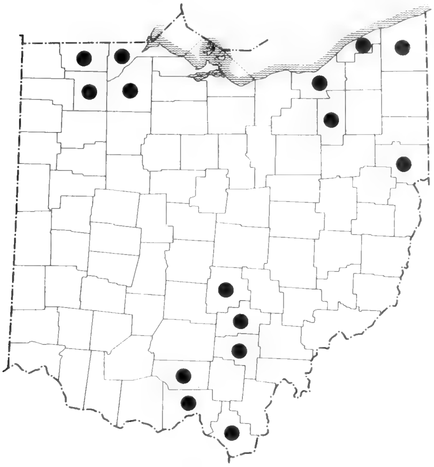

FIGURE 5. The Ohio distribution by county of *Carex rugosperma*.

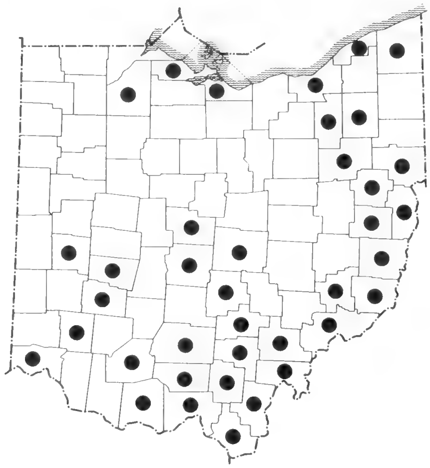

FIGURE 7. The Ohio distribution by county of *Carex umbellata*.

FIGURE 6. Large circular tussocks of *Carex rugosperma* stabilize sand dunes in the Oak Openings Metropark, Lucas County, Ohio.

species is found at scattered sites from southern Ontario to Minnesota, south to Virginia and Missouri.

Carex rugosperma plays an important ecological role in the Oak Openings. Its circular tussocks stabilize exposed sand following deforestation (Fig. 6). Scheiner (1988) discovered a high number of seeds of *C. rugosperma* in the seed bank of an oak woods on sandy soil in southern Michigan, demonstrating the ready ability of this sedge to exploit newly disturbed habitats. Under ideal conditions, such as the sand barrens of northwestern Ohio, the tussocks of *C. rugosperma* may be half a meter in breadth. The interior portion of these older plants dies, leaving an outer circle of living culms, a caricaceous fairy ring (Fig. 6).

This species was not listed for Ohio by Braun (1967) or Weishaupt (1971) although it had been collected in the state as long ago as 1896 (Cuyahoga County, CLM). It first was reported for Ohio by Cusick (1984). At that time, *Carex rugosperma* was considered endangered in Ohio. Subsequent directed surveys discovered so many populations of this species that it was dropped from the list of Ohio rarities inventoried by the Division of Natural Areas and Preserves.

Carex rugosperma occasionally is cited as *C. umbellata* Schk. ex Willd. (Fernald 1950). The treatment here follows Voss (1972) who considered the following taxon to be the true *C. umbellata*. Some authors, such as Gleason and Cronquist (1991), combine *C. rugosperma* and *C. umbellata* under the latter epithet. The two taxa are readily distinguished by the characters in the key.

Plants of *Carex rugosperma* with thick, quill-like leaves and glabrous fruits have been called var. *tonsa* (Fern.) E. Voss or *C. tonsa* (Fern.) Bickn. Pubescence is exceedingly variable in *C. rugosperma* and *C. umbellata*. Plants with glabrous to thinly pubescent fruits may be found in the same population and occasionally on the same plant. There seems to be little or no correlation between pubescence and leaf shape and texture. Plants with rigid, deeply-channeled leaves often are found in the most exposed and hostile habitats, but the stability of this leaf character has yet to be determined.

Carex umbellata Schkuhr ex Willd. (Fig. 7)

In Ohio this species is most common on the Appalachian Plateau. In central and southwestern Ohio, *Carex umbellata* is very local on the edges of bluffs and on the summits of gravel moraines where nutrients have leached from glacial deposits. *Carex umbellata* is distributed over a broad area of North America from Newfoundland to Saskatchewan, south to Tennessee.

Despite its commonness, this species was not listed for Ohio by Braun (1967) or Weishaupt (1971). *Carex umbellata* was reported by Andreas (1989), but with no indication that hers was the first publication of this species for the state.

Carex umbellata grows in similar, though more generalized, habitats to *C. rugosperma*. *Carex umbellata* forms extensive carpets in cemeteries,

mowed or grazed fields, on rocky roadbanks, and many other well-drained, sunny situations. It is extremely resilient to close mowing and cropping. The tussocks of *C. umbellata* usually are not as broad as and more irregular in shape than the circular clumps of *C. rugosperma*.

Fernald (1950) listed this species as *Carex abdita* Bickn. and applied the epithet "*umbellata*" to the taxon treated here as *C. rugosperma*.

Other Species

Two other species of *Carex* section *Acrocystis* should be sought in Ohio. They both are similar to *Carex pensylvanica* and may easily be misidentified as that species; both have elongate rhizomes like those of *Carex pensylvanica*, but may be distinguished by the characters found in the key.

Carex heliophila Mackenzie is attributed to Ohio by Kolstad (1986), but no specimens have been located in this study. This species occurs from British Columbia to southern Ontario, south to Indiana and New Mexico. It is reported from southeastern Michigan and northwestern Indiana (Crins & Ball 1983). *Carex heliophila*, as the name implies, grows in sunny prairie sites, usually in sandy substrates, and might well be found in the Oak Openings of Ohio. Synonyms include: *Carex inops* L. Bailey ssp. *heliophila* (Mackenzie) Crins; *C. pensylvanica* ssp. *heliophila* (Mackenzie) W. A. Weber; and *C. pensylvanica* var. *digyna* Boeckeler.

Carex lucorum Willd. ex Link occurs in northeastern North America from New Brunswick to New Jersey and west to Minnesota. It also is found in the southern Appalachians from West Virginia to South Carolina and Tennessee. Crins and Ball (1983) mapped this species in southeastern Michigan and eastern Kentucky. *Carex lucorum* is found in a variety of open, sandy situations, as well as in oak-pine woodlands. It should be sought in Ohio in the Oak Openings and on the Appalachian Plateau. This species also is known as *Carex pensylvanica* var. *distans* Peck.

ACKNOWLEDGMENTS

My special thanks go to A. A. Reznicek, University of Michigan, Ann Arbor, for his encouragement and valuable lessons in caricology. John Baird, James McCormac, Marilyn Ortt, and John Watts of the Division of Natural Areas and Preserves contributed numerous county records. William J. Crins, University of Toronto, and an anonymous reviewer offered many helpful suggestions. I thank the curators of the herbaria listed above for their courtesy and cooperation. My research and field study was supported by the Ohio Department of Natural Resources, Division of Natural Areas and Preserves.

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OBITUARY

Clara Gertrude Weishaupt (1898–1991)

Clara Gertrude Weishaupt, age 93, died at Greene Memorial Hospital in Xenia, Ohio, 12 August 1991. Described as "lively and devoted," she was for 22 years an outstanding teacher of general botany and local flora in the Department of Botany, The Ohio State University. Simultaneously for 18 years, Dr. Weishaupt gave dedicated service as curator of the University Herbarium and conducted research on the Ohio flora, culminating in her book, *Vascular Plants of Ohio* (1960, 1968, 1971), and two publications on the grasses of Ohio (1967, 1985).

Born 20 July 1898 to Peter and Elizabeth Barbara (Weisflock) Weishaupt, who lived on a farm west of Lynchburg in Dodson Township, Highland County, Ohio, Miss Weishaupt was educated there in a one-room elementary school and graduated from the Lynchburg High School (1916). She received a diploma in bookkeeping, shorthand, and typing from Bliss Business College, Columbus (1917). At The Ohio State University she completed three degrees, B.S. in Home Economics (1924), M.S. in Botany (1932), and the Ph.D. in Botany (1935).

As a graduate student in the OSU Department of Botany and Plant Pathology (1931–1935), she specialized in plant physiology and completed her masters thesis on the effects of ultra-violet light on plants, and her Ph.D. dissertation on diffusion of water vapor through multiperforate septa, both completed under the direction of Professor Bernard S. Meyer.

Her college teaching career initially was at the State Teachers College, Jacksonville, Alabama (1935–46), where, while holding the rank of assistant professor and later associate professor of biology, she taught courses in biology, nutrition, field botany, human physiology, industrial arts, and physical science for elementary teachers. At the time she was the only woman on the faculty with a Ph.D. degree. In the Department of Botany and Plant Pathology at The Ohio State University, Dr. Weishaupt served as instructor (1946–51), assistant professor (1951–60), associate professor (1960–68), curator of the herbarium (1949–67), and emerita associate professor (1968–1991).

While teaching local flora at The Ohio State University, Dr. Weishaupt early saw a need for a new field and laboratory manual of Ohio plants that would be useful to the students. Her first effort was a *Guide to Ohio Plants* (1952), co-authored with three other members of the Department. Later she developed her own book, *Vascular Plants of Ohio* (1960), with a revised edition (1968), and a third edition (1971), followed by several subsequent reprintings. The book is still quite popular, being used by students in local flora classes at various colleges and universities in Ohio and adjacent states.

Not trained as a plant taxonomist and with no experience in herbarium curatorial procedures, Dr. Weishaupt, upon being appointed curator of the OSU Herbarium (1949), learned quickly the methods necessary to rejuvenate the herbarium. The facility had suffered neglect in the early 1940's during World War II. She brought order to the collection, including the identification of numerous specimens, and updating the county distribution maps for the Ohio flora, conducting extensive field work throughout Ohio to obtain specimens of species from those counties not well represented in the herbarium.

When the Ohio Flora Project began in 1951, Dr. Weishaupt wrote the systematic treatment of the Gramineae, the grasses. Her work was published as part of volume I of the *Vascular Flora of Ohio, The Monocotyledoneae* (1967), the book prepared by E. Lucy Braun. Her manuscript, "A Descriptive Key to the Grasses of Ohio Based Upon Vegetative Characteristics" (1967) was used and tested in the field and herbarium during retirement years, and was published as a *Bulletin of the Ohio Biological Survey* (1985).

Clara Weishaupt was preceded in death by her parents, sister Mary McConnaughey, and brother Joseph. Two sisters, Elizabeth B. Canup of Fairborn, Ohio, with whom she lived, is now deceased, and only Rosa Murphy (age 100) of Lynchburg, Ohio, survives along with seven nieces and three nephews, several grand nieces and nephews, and great grand nieces and nephews. Dr. Weishaupt was a member of the St. Paul's Lutheran Church, Lynchburg. Funeral services were held at the Davis-Turner Funeral Home, Lynchburg, with burial in the Lynchburg Masonic Cemetery. At the funeral Prof. Ronald L. Stuckey spoke of her work at the University.

—Ronald L. Stuckey
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FIGURE 1. Clara Weishaupt at her office, June 1968. Photo by William H. Anderson.

THE BIG TREES OF MICHIGAN
1. Populus balsamifera L.

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Michigan's largest known balsam poplar, also known as hackmatack, is located in the village of Champion in Marquette County of Michigan's Upper Peninsula.

Description of the Species. Poplars are members of the willow family, Salicaceae. They are distinguished from the willows (*Salix* spp.) by their ovate to deltoid leaf blades, the several overlapping bud scales (willow buds are covered by a single scale), the coarsely toothed, lacerate or fringed bracts in the inflorescence (bracts in willow catkins are smooth edged), the cuplike disk at the base of each male flower (willows have no disk), and a flower stigma of 4 or more lobes (willow flowers have 2 stigmas which are unlobed). Voss (1985) listed seven species of *Populus* in his *Michigan Flora*. The balsam poplar is distinguished from other poplars which grow in the state by its leaf shape (ovate with a long tapering tip), rounded petioles, the sticky bud which is covered with a fragrant gum, and the presence of reddish-brown resin stains on the undersides of leaves (Fig. 1).

*Location of Michigan's Big Tree.*Champion, Michigan is a very modest village with few buildings located on U.S. Route 41 in western Marquette County. Its location is Section 32 of T48N, R29W. An unimproved road angles to the south off Rte. 41 in the "center of town." A green abandoned house and a grove of 19 balsam poplars and two white birch occupy the site. The Champion tree is in the center of the grove and is probably the parent by underground suckers of the poplar trees which surround it.

Description of Michigan's Big Tree. The tree trunk is quite sound and essentially healthy. It is still growing. The circumference of the trunk was measured on August 17, 1991 at 165″ (419 cm) [53″ (135 cm) diameter]. It was reported by Thompson (1986) at 162″ (411 cm) [52″ (132 cm) diameter]. The crown spread, however, was considerably reduced. It was 92′ (28 m) in 1986 and 57′ (17.4 m) in 1991. Since State Champion designation is based on girth only (Thompson 1986) this tree is likely to continue to be State Champion as long as it lives unless a larger one is found in the state.

The Michigan tree's trunk diverges into three trunks seven feet (2.13 m) above ground. One of the three is dead. The other two are apparently healthy, although there are 20′ (6.1 m) diebacks on several branches. Voucher specimens of this tree are filed in the Hanes Herbarium (WMU) and the herbaria at Michigan State University (MSC) and the University of Michigan (MICH).

The tree is surrounded by 18 fair-sized balsam poplars and many sap-

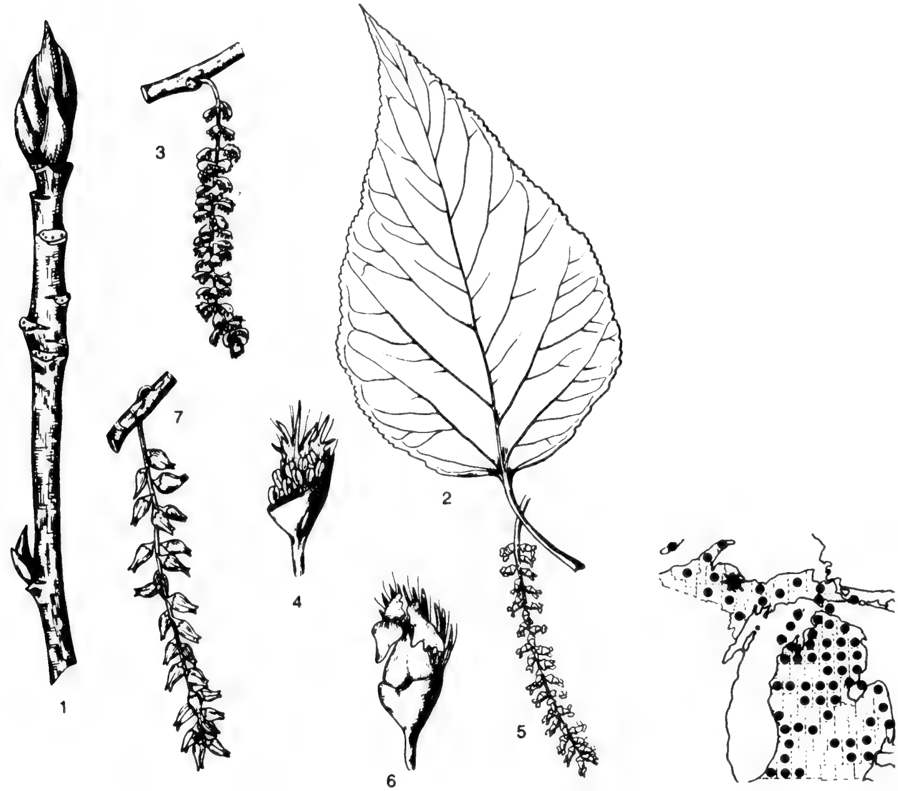

FIGURE 1. Documented distribution in Michigan and characteristics of the balsam poplar. Map is from Voss (1985), the star indicates the location of Michigan's Big Tree. Drawings are from Barnes & Wagner (1981). 1. Winter twig, × 1; 2. Leaf, × 3/4; 3. Male flowering catkin, × 1/2; 4. Male flower, enlarged; 5. Catkin of female flowers, × 1/2; 6. Female flower enlarged; 7. Fruiting catkin with capsules, × 1/2.

lings. Of the 18 large trees, six average 81″ (206 cm) girths, nine average 46″ (117 cm) girths and 3 average 22″ (56 cm) girths. Although no excavations were made, it is likely that all of these are interconnected by underground suckers. From a genetic point of view it's all one tree!

INVITATION TO PARTICIPATE

If you would like to join us in extending this series of articles by visiting and describing one or more of Michigan's Big Trees please contact one of us for help with locations, specifications for taking measurements and assistance with the manuscript. The Michigan Botanical Club encourages your

involvement in this activity. Please remember to ask permission before entering private property.

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REVIEW

ATLAS OF ONTARIO MOSSES. By Robert R. Ireland and Linda M. Ley. Syllogeus 70. Canadian Museum of Nature, Direct Mail Section, P. O. Box 3443, Station D, Ottawa, Ontario K1P 6P4. 1992. v + 138 pp. Canadian Orders: $12.78 (Canadian); non-Canadian orders: $15.95 (Canadian). Orders must be paid in advance.

Because of its calamitous history of glaciation and heavy winters, the province of Ontario would not be expected to have a moss flora of nearly 500 species. But the province is large, and it has a great diversity of habitats, ranging from subarctic to warm temperate, with a multiplicity of habitat niches provided by abundant rock, both calcareous and granitic. One would expect that some of the calciphiles are limited to the Niagara Escarpment and the Bruce Peninsula; that ephemerals are restricted to agricultural areas near Lake Erie; that species of wide distribution in the eastern United States occur in essentially similar climates of southern Ontario; or that arctic species are limited to the shores of Hudson Bay. Of the species mapped, at least 133 can be considered rare or localized. The spottiness of distribution can be attributed, to an extent at least, to a lack of collections rather than special edaphic or climatological factors.

Behind the 490 dot maps showing known occurrences stands a prodigious amount of work and, in the case of these authors, very careful and competent work. The maps will surely stimulate collection and serve an important floristic and phytogeographic end.

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ANNOUNCEMENT
The Ohio State University Herbarium Public Lectures and Workshops

Lectures: The World of Biodiversity

As we begin our first full year at the OSU Museum of Biological Diversity, and our one-hundred-first year of service, we are taking an opportunity to highlight the importance of biological diversity. Our speakers will cover a broad spectrum of topics, ranging from the incredible variety of plants and animals with which we live, to the severe stresses placed on them by modern human life, to some of the research being undertaken to gain a better understanding of this diversity. We will conclude this year's series with a tribute to Emanuel D. Rudolph, the OSU Herbarium's curator of cryptogams, who tragically died in an automobile accident in June. Each Lecture is free and will be presented on the first Tuesday of the month.

December 1	**Searching for Peonies in China.** Tao Sang, Graduate Associate, The OSU Herbarium.
January 5	**The Impact of Global Environmental Change on Biodiversity.** Peter Curtis, Assistant Professor, Department of Plant Biology.
February 2	**The Diverse World of Trees.** John J. Furlow, Supervisor, The OSU Herbarium.
March 2	**Why Was the Creator So Inordinately Fond of Beetles?** Charles Triplehorn, Curator Emeritus, The OSU Entomology Collection.
April 6	**A Botanical Tour of the Islands of Korea.** Tod F. Stuessy, Director, The OSU Herbarium.
May 4	**The Botanical Contributions of Emanuel D. Rudolph.** Ronald L. Stuckey, Curator Emeritus, The OSU Herbarium.

Workshops

This year we will continue our series of mini-classes, each led by an expert in the particular group, to help you master the important features, diversity, and identification of two "challenging" groups of plants, the lichens and the fungi. We hope you will join us for one or more of these workshops.

January 16	**A Fleshy Fungi Workshop.** Wayne Ellett, Professor Emeritus of Plant Pathology.
May 15	**A Lichen Workshop.** Ray Showman, American Electric Power Co.

The lectures begin at 8:00 P.M. in the auditorium (Rm. 1120) of the Museum of Biological Diversity, 1315 Kinnear Road. Refreshments and an opportunity to meet the speakers will be available afterwards in the Herbarium, Rm. 1350. The workshops will meet in the museum classroom, Rm. 1504, Museum of Biological Diversity, from 8:00 A.M. to 12:00 noon.

The size of workshop groups must be limited, so if you want to take part in one of these, **you must first reserve a place.** Please call the Herbarium (614–292–3296) any time prior to the date of the program in which you would like to take part, and we will add you to our list or be glad to answer any questions you might have.

Parking is available in the lot in front of the Museum building. For further information, call Dr. John Furlow at (614) 292–3296.

MICHIGAN PLANTS IN PRINT
New Literature Relating to Michigan Botany

Continued from this journal 31: 68 (1992). For description of this series, see 26: 174 (1987).

—Edward G. Voss

B. BOOKS, BULLETINS, SEPARATE PUBLICATIONS

Crum, Howard. 1988. A Focus on Peatlands and Peat Mosses. Univ. Michigan Press, Ann Arbor. 306 pp. $49.50. [Much of the content, including pictures, from Michigan; see extended review in this journal 29: 138–140. 1990.]

Crum, Howard. 1991. Liverworts and Hornworts of Southern Michigan. Univ. Michigan Herbarium, Ann Arbor. 233 pp. $18.00. [Intended to replace the earlier (and less complete) work by Steere; see review in this journal 30: 134–135. 1991.]

Vander Kloet, S. P. 1988. The Genus Vaccinium in North America. Agric. Canada Publ. 1828. 201 pp. $55.80 outside Canada; $46.50 in Canada. [A thorough treatment, with keys and distribution maps, of the blueberries, bilberries, and cranberries. *V. oxycoccos* and *V. cespitosum* are consistently misspelled and map dots are often unusually sparse in Michigan—considering that the University of Michigan herbarium is one said by the author to have been examined. Field collections included *V. pallidum* from Washtenaw Co. For a paperback, this handy volume is priced beyond the average user.]

C. JOURNAL ARTICLES

Abrams, Marc D., & Donald I. Dickmann. 1983. Response of understory vegetation to fertilization on mature and clear-cut jack pine sites in northern Lower Michigan. Amer. Midl. Nat. 110: 194–200. [*Carex pensylvanica* showed above-average response to fertilization in Crawford and Ogemaw counties, although other factors are also involved in expansion following burning and clear-cutting.]

Beitel, Joseph M., Warren H. Wagner, Jr., & Kerry S. Walter. 1981. Unusual frond development in sensitive fern Onoclea sensibilis. Amer. Midl. Nat. 105: 396–400. [Study of a population in Van Buren Co.]

Beitel, Joseph M., & Florence S. Wagner. 1982. The chromosomes of Lycopodium lucidulum. Amer. Fern. J. 72: 33–35. [Mentions a count of 66–69 pairs in material from Livingston Co.]

Bowden, Wray M. 1982. The taxonomy of Lobelia ×speciosa s.l. and its parental species, L. siphilitica and L. cardinalis s.l. Canad. J. Bot. 60: 2054–2070. [Cites a collection from Douglas Lake with the stem pubescent above, and two names that cannot be typified, which were published by Coleman in his 1874 catalog of plants of the southern peninsula.]

Brandenburg, David M., James R. Estes, & Scott L. Collins. 1991. A revision of Diarrhena (Poaceae) in the United States. Bull. Torrey Bot. Club 118: 128–136. [Distribution map shows *D. americana* in 5 Michigan counties.]

Brandenburg, David M., Will H. Blackwell, & John W. Thieret. 1991. Revision of the genus Cinna (Poaceae). Sida 14: 581–596. [Outlines on generalized range maps for North America indicate Michigan distribution of *C. latifolia* and *C. arundinacea*.]

Brodo, Irwin M., & William Louis Culberson. 1987 ["1986"]. Haematomma pustulatum, sp. nov. (Ascomycotina, Haematommataceae): A common, widespread, sterile lichen of eastern North America. Bryologist 89: 203–205. [Distribution map shows two localities in northern Michigan, apparently Isle Royale and Emmet Co.]

Brown, Robert T., & Allison D. Slavick. 1983. Allelopathy in a jack pine forest. Michigan Academ. 15: 285–292. [Lichens inhibit growth of mosses as well as vascular plants at an unspecified site "in Michigan."]

Carlson, Thomas M. [sic], & W. H. Wagner, Jr. 1982. The North American distribution of the genus Dryopteris. Contr. Univ. Michigan Herb. 15: 141–162. [Dot distribution maps for 10

species include Michigan, though without county lines. Middle initial of first author should be J.]

Cid-Benevento, Carmen R. 1987. Distributional limits of old-field and woodland annual herbs: The relative importance of seed availability and interference from herbaceous vegetation. Amer. Midl. Nat. 117: 296–306. [Study of *Chenopodium album* and *Pilea pumila* in Kalamazoo Co.]

Cochran, M. Ford. 1990. Back from the brink chestnuts. Natl. Geogr. 177(2): 128–140. [Includes 6 paragraphs on hypovirulence and seedling growing in Michigan, as well as map which omits several well known and documented Michigan locations for trees both native and surviving beyond the natural range.]

D'Arcy, William G., Kathy Pickett, & Richard C. Keating. 1990. Investigation into Leucophysalis grandiflora. Wildflower 3(2): 20–26. [Observations largely on material of Michigan origin, including germination methods.]

Ewert, David. 1982. Birds in isolated bogs in central Michigan. Amer. Midl. Nat. 108: 41–50. [Includes brief descriptions of vegetation in 4 bogs in Clare and Isabella counties.]

Gadella, T. W. J. 1985 ["1984"]. Notes on Symphytum (Boraginaceae) in North America. Ann. Missouri Bot. Gard. 71: 1061–1067. [Cites two Cheboygan Co. collections of S. ×uplandicum, which is more common in N. A. than *S. asperum*; includes full key to species and hybrids.]

Gastony, Gerald J. 1988. The Pellaea glabella complex: Electrophoretic evidence for the derivations of the agamosporous taxa and a revised taxonomy. Amer. Fern J. 78: 44–67. [Outline distribution map includes Michigan in the range of only agamosporous tetraploid *P. glabella* var. *glabella*.]

Glime, Janice M., Robert G. Wetzel, & Betty J. Kennedy. 1982. The effects of bryophytes on succession from alkaline marsh to sphagnum bog. Amer. Midl. Nat. 108: 209–223. [Study at Lawrence Lake, Barry County.]

Gross, Ronald S., & Patricia A. Werner. 1983. Probabilities of survival and reproduction relative to rosette size in the common burdock (Arctium minus: Compositae). Amer. Midl. Nat. 109: 184–193. [Study in Kalamazoo County.]

Henebry, M. S., J. Cairns, Jr., C. R. Schwintzer, & W. H. Yongue, Jr. 1981. A comparison of vascular vegetation and protozoan communities in some freshwater wetlands of northern Lower Michigan. Hydrobiologia 83: 353–375. [Includes data on vegetation and water chemistry at 7 wetlands in Emmet and Cheboygan counties.]

Hileman, Douglas R., & Lytnda Fox Lieto. 1981. Mortality and area reduction in leaves of the bog shrub Chamaedaphne calyculata (Ericaceae) caused by the leaf miner Coptodisca kalmiella (Lepidoptera: Heliozelidae). Amer. Midl. Nat. 106: 180–188. [Study in a bog in Livingston County.]

Kangas, Patrick C., & Gary L. Hannan. 1985. Vegetation on muskrat mounds in a Michigan marsh. Amer. Midl. Nat. 113: 392–396. [Study site was in Ann Arbor; 26 species (not all identified) found on 17 mounds.]

Kraft, Kenneth J., & Frederic H. Erbisch. 1991 ["1990"]. The thimbleberry gallmaker, Diastrophus kincaidii (Hymenoptera: Cynipidae), in the Great Lakes region. Great Lakes Entomol. 23: 195–200. [Account of galls noted in Michigan within the past decade, though long known on *Rubus parviflorus* in western North America.]

Leitner, Lawrence A., James A. Reinartz, & Donald H. Les. 1991. Distribution and habitats of forked aster (Aster furcatus), a threatened Wisconsin plant. Field Station Bull. (Univ. Wisconsin-Milwaukee) 24(2): 1–14. [Distribution map for the species includes 3 dots in Michigan, apparently Monroe, Midland, and one other (Washtenaw?) counties, with no further data.]

Marino, Paul C. 1988. The North American distributions of the circumboreal species of Splachnum and Tetraplodon. Bryologist 91: 161–166. [Dot maps for *S. ampullaceum* and *S. sphaericum* include Michigan localities.]

McQueen, Cyrus B. 1989. A biosystematic study of Sphagnum capillifolium sensu lato. Bryologist 92: 1–24. [Distribution maps include Michigan dots for *P. albocaerulescens, P. calcarea, P. crustulata, P. diversa, P. macrocarpa, P. speirea, P. thomsonii,* and *Amygdalaria panaeola*—although for almost all of these, specimens cited from Isle Royale are apparently mapped from the mainland of Keweenaw County.]

Metzger, Fred, & Jan Schultz. 1984. Understory response to 50 years of management of a northern hardwood forest in Upper Michigan. Amer. Midl. Nat. 112: 209–223. [Understory similar to original condition after 50 years on clearcut plots near Marquette.]

Moore, Michael O. 1991. Classification and systematics of eastern North American Vitis L. (Vitaceae) north of Mexico. Sida 14: 339–367. [Ranges are stated in terms of farthest limits, and for only *V. labrusca* is Michigan thus mentioned.]

Moran, Robbin C. 1982. The Asplenium trichomanes complex in the United States and adjacent Canada. Amer. Fern J. 72: 5–11. [Distribution maps include Michigan dots for both diploid and tetraploid *A. trichomanes*.]

Mulligan, Gerald A., & Derek B. Munro. 1990 ["1989"]. Taxonomy of species of North American Stachys (Labiatae) found north of Mexico. Nat. Canad. 116: 35–51. [*S. hyssopifolia* mentioned from Michigan; *S. palustris* restricted to Eurasian plants introduced in N. A. (but not in Michigan), ours being *S. pilosa*. *S. hispida* maintained as distinct from *S. tenuifolia* on basis of petiole length.]

Overlease, William R. 1991. Genetic relationships between three species of oaks as determined by common garden studies with populations from Michigan, Indiana, and Wisconsin. J. Pennsylvania Acad. 65: 71–74. [Northern sources of seed included Sault Ste. Marie, Traverse City, Indian River, Douglas Lake, and Honor.]

Rohrer, Joseph R., & Helen E. Kirkpatrick. 1985. Pseudoscleropodium discovered in the Great Lakes region. Bryologist 88: 24–25. [First record of the moss *P. purum* from interior of North America, from adjacent to arboretum of University of Michigan, Ann Arbor.]

Sakai, Ann K., & JoAnne Sulak. 1985. Four decades of secondary succession in two lowland permanent plots in northern Lower Michigan. Amer. Midl. Nat. 113: 146–157. [Study in Reese's Swamp at north end of Burt Lake, Cheboygan County.]

Sakai, Ann K., Mark R. Roberts, & Claudia L. Jolls. 1985. Successional changes in a mature aspen forest in northern Lower Michigan: 1974–1981. Amer. Midl. Nat. 113: 271–282. [Study in Cheboygan County, on site described in Michigan Bot. 17: 72–79. 1978.]

Scott, Michael L., & Peter G. Murphy. 1987. Regeneration patterns of northern white cedar, an old-growth forest dominant. Amer. Midl. Nat. 117: 10–16. [Study on South Manitou Island.]

Sork, Victoria L., 1983. Mast-fruiting in hickories and availability of nuts. Amer. Midl. Nat. 109: 81–88. [Study in oak-hickory forest at Haven Hill, Oakland County.]

Steggall, John W., & John H. Judd. 1983. Recent and historical changes in the aquatic macrophyte community of First Sister Lake, Washtenaw County, Michigan. Michigan Academ. 15: 209–220.

Stephenson, Andrew G. 1981. Toxic nectar deters nectar thieves of Catalpa speciosa. Amer. Midl. Nat. 105: 381–383. [Observations at floodplain of Fleming Creek, University of Michigan Botanical Gardens.]

Terrell, Edward E. 1991. Overview and annotated list of North American species of Hedyotis, Houstonia, Oldenlandia (Rubiaceae), and related genera. Phytologia 71: 212–243. [Explicitly includes Michigan in the stated range of *Hedyotis nigricans* and *Houstonia canadensis*, but not *Houstonia purpurea* var. *calycosa*, confirmed in the state by the author's annotations in 1957, but allowed to range only "north to southern parts of Ohio, Indiana, and Illinois."]

Thomson, John W. 1987. The lichen genera Catapyrenium and Placidiopsis in North America. Bryologist 90: 27–39. [*C. michelii* the only species mapped and cited from Michigan (Isle Royale); *P. minor* cited from Livingston County.]

Timdal, Einar. 1987 ["1986"]. A revision of Psora (Lecideaceae) in North America. Bryologist 89: 253–275. [*P. globifera* the only species of this lichen genus mapped as occurring in Michigan (U.P.).]

Vickery, Robert K., & Sun Szen Hsu. 1984. Esterase variation associated with elevation, latitude and ploidy level in populations of the Mimulus glabratus complex. Amer. Midl. Nat. 111: 96–104. [Origin of one population, of *M. glabratus* var. *michiganensis*, was "Carp Creek, Pellston, Cheboygan Co."—a contradictory statement.]

Vickery, Robert K., Jr., Steven R. Pack, & Thong Mac. 1990. Chromosome counts in section Simiolus of the genus Mimulus (Scrophulariaceae). X. M. glabratus complex (cont.). Madroño 37: 141–144. [*M. glabratus* ssp. *fremontii* from Epoufette and *M. glabratus* ssp. *michiganensis* from Maple River both have n = 15.]

Vickery, Robert K., Jr. 1990. Close correspondence of allozyme groups to geographic races in the Mimulus glabratus complex (Scrophulariaceae). Syst. Bot. 15: 481–496. [Includes data from Michigan populations of ssp. *michiganensis* from Emmet Co. and ssp. *fremontii* from Mackinac Co. and "Pellston, Cheboygan Co."– a contradictory indication.]

Vickery, Robert K., Jr. 1991. Crossing relationships of Mimulus glabratus var. michiganensis (Scrophulariaceae). Amer. Midl. Nat. 125: 368–371. [Origin of the material studied of the variety was Maple River, Emmet County.]

Wallace, Gary D. 1975. Studies of the Monotropoideae (Ericaceae): Taxonomy and Distribution. Wasmann J. Biol. 33: 1–88. [Generalized shaded distribution maps for 2 species of *Monotropa* include all of Michigan; dot map for *Pterospora* includes several of the Michigan localities (additional are in Michigan Bot. 20: 70. 1981).]

Weathers, Kathleen, & Thomas G. Siccama. 1986. A comparison of nutrient concentrations in two poisonous and three non-poisonous species of sumac (Rhus spp.). Amer. Midl. Nat. 116: 209–218. [Three of the 25 collecting sites were in "southwestern Michigan" but it is not stated which (if not all) species came from there and data on chemical analyses are apparently pooled for each species anyway.]

Werner, Patricia A. 1975. The effects of plant litter on germination in teasel, Dipsacus sylvestris Huds. Amer. Midl. Nat. 94: 470–476. [Material obtained and grown in Ingham County.]

Werner, Patricia A., & Amy L. Harbeck. 1982. The pattern of tree seedling establishment relative to staghorn sumac cover in Michigan old fields. Amer. Midl. Nat. 108: 124–132. [Study in Kalamazoo County.]

Werth, Charles R. 1991. Isozyme studies on the Dryopteris "spinulosa" complex, I: The origin of the log fern Dryopteris celsa. Syst. Bot. 16: 446-461. [Populations sampled for *D. goldiana* and *D. celsa* included Washtenaw and Kalamazoo counties, respectively.]

EDITOR'S NOTE

MAILING DATES–VOLUMES 29-31

You may have noticed that the mailing date of the previous issue that usually appears on the inside back cover has only rarely appeared recently. The omission has been accidental on occasion, deliberate in some cases when an issue went to the printer before the previous issue had been mailed.

29(1): June 5, 1990
29(2): September 10, 1990
29(3): November 27, 1990
29(4): March 28, 1991
30(1): August 15, 1991
30(2): October 23, 1991
30(3): December 31, 1991
30(4): May 4, 1992
31(1): August 14, 1992
31(2): September 10, 1992

–Richard K. Rabeler

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On the cover: *Hampton Creek, Gourdneck State Game Area, Kalamazoo County, Michigan*

Photographed by Richard W. Pippen

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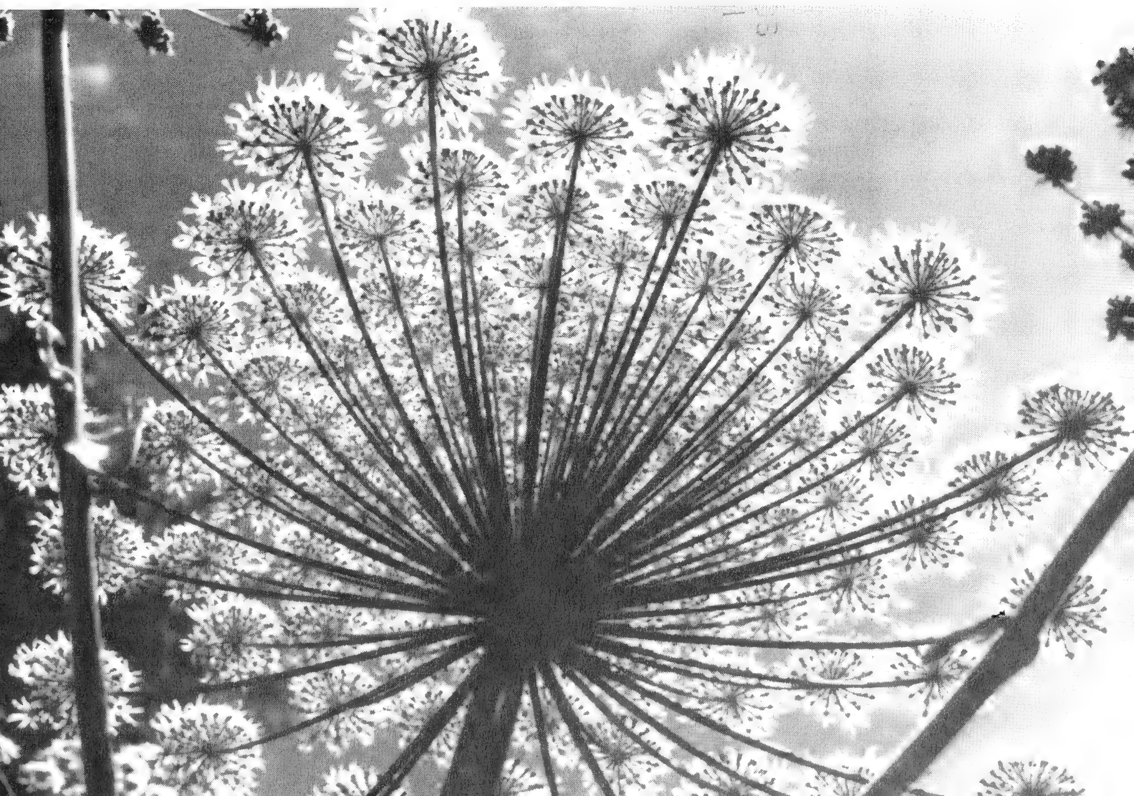
THE MICHIGAN BOTANIST

October, 1992



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Articles dealing with any phase of botany relating to the Great Lakes Region may be sent to the Co-editors. In preparing manuscripts, authors are requested to follow our style and the suggestions in "Information for Authors" (Vol. 28, p.43; Vol. 29, p.143).

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BOTANICAL AND HORTICULTURAL CONTRIBUTIONS OF MRS. WILLIAM A. KELLERMAN (STELLA VICTORIA (DENNIS) KELLERMAN), 1855–1936[1]

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Stella Victoria (Dennis) Kellerman (1855–1936), was an active but relatively unknown botanist and horticulturist with many talents. As the wife of William Ashbrook Kellerman (1850–1908), she assisted him in many phases of his extremely active botanical career, principally at Kansas State University, Manhattan, and The Ohio State University, Columbus. Mrs. Kellerman's interest in botany centered around the illustration of plants, the study of the local floras of Kansas and Ohio, the morphological variations of leaves and flowers, and the culture of garden flowers. Her interpretation of the morphology of the inflorescences of the corn plant has relevant implications for present-day thinking on the origin of this economically important grass. Mrs. Kellerman has been given credit as being the first investigator to write that the ear is the homolog of the central spike of the tassel. Biographical information is scarce, but highlights of her life and contributions to botany and horticulture are recorded in two memoranda written about William A. Kellerman by their daughter, Mrs. Maude (Kellerman) Swingle (1953, 1964) and in a recent book (Stuckey 1992, p. 15). From these accounts and other sources (Anonymous 1908, Humphrey 1961), the following narrative has been developed.

PERSONAL LIFE AND EARLY BOTANICAL INTERESTS

Stella Victoria Dennis (Fig. 1), born 25 July 1855 in Amanda, Fairfield County, Ohio, was the daughter of Anthony Dennis, a physician of broad interests and scientific curiosity. At an early age, she attended the Academy at Cedar Hill, Fairfield County, Ohio, where one of her teachers was William A. Kellerman, whose home was in nearby Ashville, Pickaway County. At the age of twelve, as the story is told, she decided that someday she would marry him. In the meantime, he received a Bachelor of Science degree in 1874 from Cornell University, Ithaca, New York, and she gradu-

[1]Published in celebration of the Centennial of The Ohio State University Herbarium, founded by Professor William A. Kellerman, 1891. Parts of this paper were read 29 April 1989 at the 98th annual meeting of the Ohio Academy of Science, Cuyahoga Community College, Parma, Ohio (Stuckey 1989).

FIGURE 1. Undated photograph of Mrs. William A. Kellerman. From the Portrait Archives, The Hunt Institute for Botanical Documentation, Carnegie-Mellon University, Pittsburgh, Pennsylvania. Another small [and not well-reproduced] photograph appears in Ohio J. Sci. 41: 307. 1941.

ated from a female academy, whose name has not been learned, with the degree "Mistress of Letters."

Young Miss Dennis had a definite interest in wild plants, as recorded in her later publications. In one article, she described an incident which would have occurred some 20 years earlier, when she was about 18 years of age:[16 (footnote 2 below)]

> Years ago the return of spring was hailed with delight, and the first wild flowers were sought with the keenest pleasure. The Spring Beauty, (*Claytonia*), *Erythronium*, and blue violet were my favorites. Often besides gathering bouquets the plants were dug up, taken home and planted in some nooks or corner of a flower bed. I finally had quite a wild garden, as they grew and wandered beyond the border of the flower-bed, making themselves quite at home in the sod of the lawn, or yard, as we said then.

In 1876, while William A. Kellerman was teaching natural sciences at the State Normal School in Oshkosh, Wisconsin, the two traveled and were married on 25 July 1876 at Ithaca, New York. They took a honeymoon to the United States Centennial Celebration in Philadelphia, and there they enjoyed the sight of such curiosities as the newly-invented telephone. William continued to teach in Oshkosh until 1879, when the couple sailed for Europe, where he attended the Universities of Göttingen and Zürich and received the degree Doctor of Philosophy from the latter institution in 1881. Upon returning to the United States, Dr. Kellerman taught botany and horticulture for one year at the State College of Agriculture and Mechanic Arts, Lexington, Kentucky.

In the home of one of his European professors, Kellerman had seen some botanical illustrations made by the professor's wife, and realized how much help a talented spouse could provide. He promptly arranged for special drawing lessons for his wife, who had already acquired some artistic skill through training from her father. After leaving Kentucky, the family, which now included a son and a daughter, returned to Ohio, where they lived with Mrs. Kellerman's parents in Amanda. While there, Dr. Kellerman wrote his *Elements of Botany* (1883), an elementary textbook "prepared especially for pupils who end their school education when, or even before, the ordinary high-school course is completed." In the preface, Dr. Kellerman acknowledged his wife's effort: "I have been assisted by my wife in the entire preparation of the book, and to her equally with myself is to be attributed any merit that it may contain." Nearly three hundred of the illustrations were original and, according to their daughter (Swingle 1964), were prepared by Mrs. Kellerman, who also meticulously copied the manuscript for the printer.

In the fall of 1883, Dr. Kellerman was asked to establish a Department of Botany at the Kansas State Agricultural College, now Kansas State University, Manhattan. During his first year there (1884), he published *Kellerman's Plant Analysis: A Classified List of the Wild Flowers of the Northern*

[2]Numbers in superscript are citations to Mrs. Kellerman's published papers numbered and listed chronologically in Appendix I.

United States, with Keys for Analysis and Identification. In the preface, he noted that Mrs. Kellerman had again "rendered valuable assistance in the preparation of the book, especially in the elaboration of the keys." Jointly, they published two papers on the vascular flora of Kansas, both of which emphasized keys as a means for identification of the plants (Kellerman & Kellerman 1887, 1888).

STUDIES OF LEAF VARIATION

While in Kansas, Mrs. Kellerman became interested in the many morphological variations in leaves and she began to study them critically. As she stated in a later publication, the leaves of *Parthenocissus quinquefolia* (L.) Planch. (*Ampelopsis quinquefolia* Michaux) first attracted her attention in this context.[74] Her first major contribution to the subject was a paper entitled "Evolution in leaves," read at the annual meeting of the Kansas Academy of Science in 1889 and published a year later in the Academy's *Transactions*.[3] Her illustration showing leaf variations is reproduced here from that paper (Fig. 2).

In 1891, William A. Kellerman accepted the position of chairman of the newly-formed Department of Botany at The Ohio State University (Rudolph & Stuckey 1969, Meyer 1983). Here Mrs. Kellerman continued her studies on morphological variation and evolution in leaves of vascular plants, publishing over 20 papers on the subject from 1892 to 1903. Her most detailed and substantive papers on the subject were studies on variation in cinquefoil[12], horse-radish[14, 24], blackberry[33], tulip tree[44, 45, 61], sassafras[47], and hop vine.[67] She wrote on variation in flowers and fruits[11, 51, 52, 69, 70], petioles and stipules[12, 15, 26, 45], the structure of the ear and tassel of the primitive Indian corn[27, 34, 35], and on the doubling of flowers in trillium[59, 63], and hollyhock.[69]

For a number of years, the variation in leaves of *Liriodendron* (tulip tree) was of special interest to Mrs. Kellerman, and was the subject of three papers that appeared in *Meehan's Monthly*.[44, 45, 61] In the first paper[44], she noted that the three trees which stood in the "spacious front yard of the old homestead" in Amanda, Ohio, were long-time "intimate friends." She illustrated five leaf variants and explained that they were representatives of past ages and were controlled by heredity. In an appended note, the editor referred to these changes as explainable by the "theory of variation in the degree of growth force." In the second paper[45], she illustrated immature leaves, showing that the stipules were adnate, a situation not previously believed to occur, but suggestive of the idea that early ancestral forms of the stipules also were adnate. In the third paper[61], she attempted to relate leaf variation to degrees of growth energy in the plant. The leaf variations that Mrs. Kellerman described were illustrated in her paper and are reproduced here (Fig. 3). In a paper illustrating the shapes of leaves on a single Sassafras tree[47], Mrs. Kellerman was intrigued by the tremendous variation, but she was unable to offer any explanation for the phenomenon. Her broad

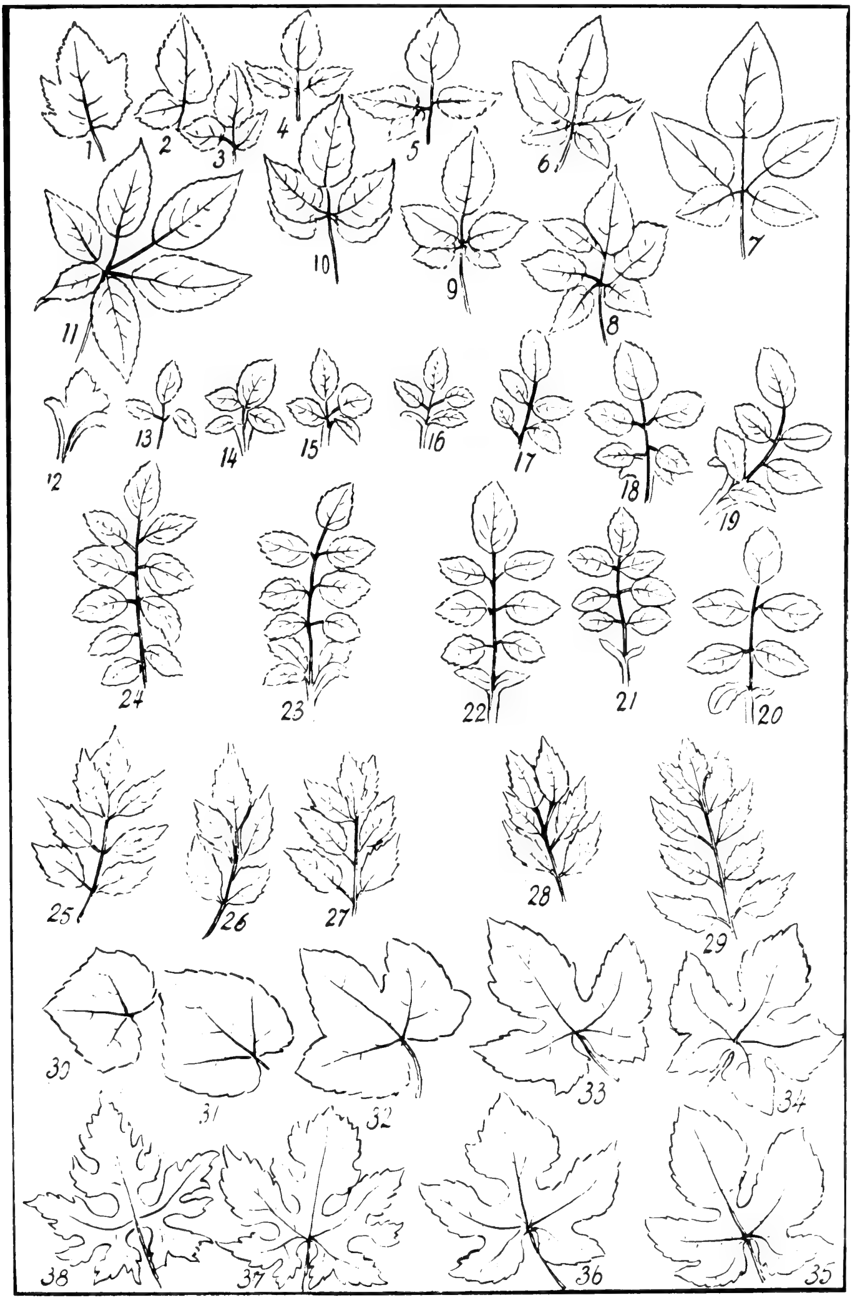

FIGURE 2. Illustrations of variations in leaves from Mrs. Kellerman's paper in Trans. Kansas Acad. Sci. 1889 12: 168-173. 1890.

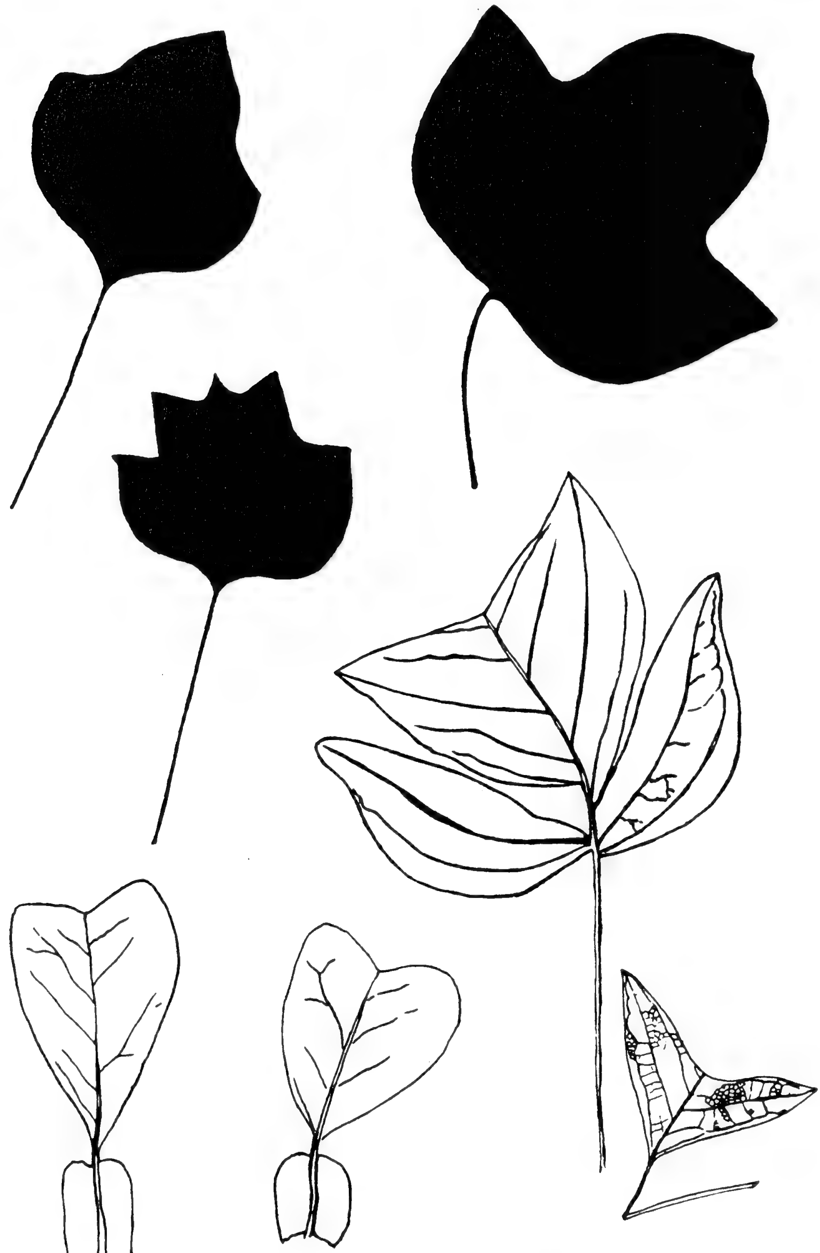

FIGURE 3. Illustrations of leaf variations in *Liriodendron tulipifera* redrawn from Mrs. Kellerman's papers in Meehan's Monthly 6: 104–105, 145. 1896.

overview of leaf variation appeared in the *Journal of the Cincinnati Society of Natural History* (1893)[9] and was the most thought-provoking work that she produced on the subject while she lived in Ohio. Her illustration of variable leaves is reproduced from that paper (Fig. 4).

PUBLICATIONS IN BOTANY AND OTHER TOPICS

Mrs. Kellerman's 80 known papers were printed in eight of the professional scientific and popular horticultural journals of the period (Appendix I). Most of her articles in scientific journals appeared in *Science* and in the publications of the state scientific academies of Kansas and Ohio. Many of her articles appeared in the popular horticultural magazines *Meehan's Monthly and Vick's Illustrated Monthly Magazine* (Table 1).

Mrs. Kellerman described the following experience in teaching botany that apparently occurred while she was living in Kansas.[54]

> Some years ago we lived about midway between the village and the country school. The distance to either school seemed too great for my little ones to attend. My neighbor across the way and I concluded that the only way out of the difficulty was to teach our children at home. One of the things I did was to form a little class in botany, which the neighbor's children were invited to join. We had such a pleasant and profitable time together that I have been wondering whether I might not be able to help some other boys and girls who would like to know something about plants and flowers, but who feel that they do not know how to learn about them without the aid of a teacher. Boys and girls, especially those who live in the country and have such excellent opportunities for collecting and studying plants, ought to be able to take advantage of their good fortune. They may need just a little outside stimulus to induce them to take an interest in the green and growing things about them . . . [Those who] consider themselves members of the class . . . will begin work at once,—or play, rather, for we will find it great fun to learn a little about plants . . . .

Mrs. Kellerman's botanical curiosity and her willingness to attempt solutions to problems make for delightful reading. To return to the story of the spring wildflowers that she had planted in her flower-bed, Mrs. Kellerman wrote:[16]

> . . . [A]fter an interval of twenty years, I visited that old door-yard, and what was my surprise to find that the blue violet had monopolized it all! There was absolutely nothing else. All the flower beds of twenty years ago were merged into one great bed of violets. Not a blade of grass, not a Spring Beauty, nor an Erythronium was to be seen.
>
> My curiosity as to the reason why the violet was able to gain so completely the ascendency was thoroughly aroused. I found no blossoms which had perfected seed, though the plants had bloomed profusely. Pulling up several branches I found many of those peculiar seed pods, which appear as if seeking concealment at the base of the plant, bending down towards the roots, quite out of view.

Mrs. Kellerman never really offered any solution to this problem, but did raise some questions:[16]

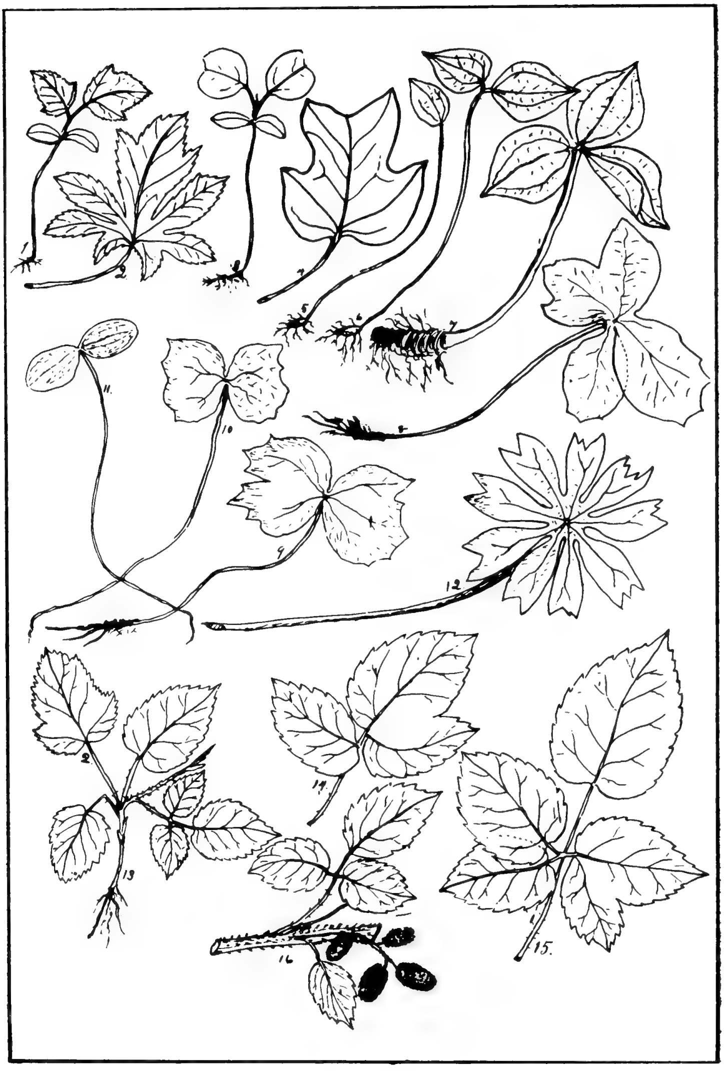

FIGURE 4. Illustrations of variations in leaves from Plate II in Mrs. Kellerman's paper in J. Cincinnati Soc. Nat. Hist. 16: 49–53. 1893. Each leaf is numbered and identified as follows: 1. Germinating plantlet of *Liquidambar styraciflua* L. 2. Leaf from *Liquidambar* tree five or six years old. 3. Germinating plantlet of *Liriodendron tulipifera*. 4. Typical leaf of *Liriodendron tulipifera*. 5, 6, 7. First, second, and third year's growth of *Trillium grandiflorum*. 8–12. *Podophyllum peltatum*; 11, first years' growth; 8, 9, 10, growth of second year; 12, peltate leaf, which does not appear until third year. 13. Seedling of *Rubus villosus*, showing that the first leaves to appear are simple. 14. Leaf of *R. villosus*, showing a transition stage preceeding the common trifoliate form. 15. Leaf of same, illustrating the development of the quinquefoliate, from the trifoliate form. 16. A portion of a fruiting cane of *R. villosus*, with trifoliate and simple leaves at the base of fruit clusters. (The simple leaf alone being found toward extremity of cane).

TABLE 1. DISTRIBUTION OF 80 PAPERS PUBLISHED IN EIGHT JOURNALS BY MRS. W. A. KELLERMAN

Name of Journal	Years	No. of Papers	General Topics
Trans. Kansas Acad. Sci.	1887, 1890	2	trees; leaf variation
Science	1891–1908	12	various
J. Cincinnati Soc. Nat. Hist.	1893	1	leaf variation
Meehan's Monthly	1893–1900	22	various
Vick's Illustrated Monthly Mag. (also as Vick's Illustrated Family Mag.)	1893–1903	39	various
Annual Rep. Ohio State Acad. Sci.	1894, 1898	2	Indian corn; double trillium
Asa Gray Bull.	1898	1	double trillium
J. Columbus Hort. Soc.	1900	1	non-indigenous flora of Ohio

> Now, is it not a little strange, a good subject for 'speculation,' indeed, that the violet . . . still produces its seed in this secluded manner from buds which never open? . . . since new plants spring from the rhizome in such prolificacy, why this abundant production of seed? Is the plant in a transition state still uncertain as to which mode of reproduction will best answer the purpose of perpetuation?

In another article, Mrs. Kellerman was concerned about the bees and the clover.[43]

> I have always thought it a great fraud to claim that bumble bees are necessary to fertilize the clover. For several years past especially, I have thought of it. I have driven, with my horse and pony, long, long drives, through the spring, summer and fall. Great fields of clover bordered the roadside, and as I enjoyed the delicious odor, I always drove slowly whenever I came to a clover field, and watched for bumble bees. How few I saw! It was dreadful to think that those few bumble bees must visit every clover head, and every floret in each head! . . . I came to think it simply nonsense to believe it true . . . .

Among other topics about which Mrs. Kellerman wrote were the virtues of having cultivated flowers in gardens, pots, or hanging baskets[31, 32, 37, 38, 46, 75], and she urged her readers to pursue this kind of activity. Among the plants that she discussed were gladioli and tulips[49], cleome[50], dahlia[53], blackberry[60], roses[66], crocus[68], Chinese primrose[71], *Linaria cymbalaria* Miller[73, 75], and *Ampelopsis cordata* Michaux[74], the last she illustrated photographically as a large vine covering the front porch on the north side of her home at 175 West Eleventh Avenue, Columbus (Fig. 5). On another occasion, she described an ample crop of several vegetables grown in a 4 × 6-foot clay bank in the limited garden space at her Lexington home.[23] She visited the greenhouses of the Department of Horticulture at The Ohio State University and commented on the beds of lettuce and radishes and the technique for growing mushrooms under the benches there.[22]

Mrs. Kellerman's account of the annual meeting of the American Association for the Advancement of Science, held 21–23 August 1899 on the campus of The Ohio State University, provides interesting contrasts with

FIGURE 5. Photograph of *Ampelopsis cordata*, a planted vine from Kansas growing on the north side of the Kellerman home at 175 West 11th Avenue, Columbus, Ohio. Taken from Mrs. Kellerman's paper in Vick's Illustrated Monthly Mag. 23: 101–102. 1900.

present-day American Institute of Biological Sciences (AIBS) meetings, usually held during summers on college campuses.[76]

> . . . [T]he buildings were remote from disturbances by business traffic, and the large campus, with its beautiful trees, many of which are of nature's planting, was a charming place to linger and rest, after the free luncheon which was served daily to the entire body in the Gymnasium Hall. It was noted that a larger proportion of the older and more distinguished members were in attendance. The section of botany was remarkably well represented . . . One was impressed with the advancement of botany . . . Systematic botany, which only a few years ago was the chief field in which botany was developed, seemed but a small fractional part of what is meant by botany at the present, while histology and ecology are constantly growing in importance. The methods have improved so much in late years in laboratory work—microscopes, microtomes, and all appliances and laboratory equipments make it possible for the prosecution of work which would have been impossible only a short time ago. The whole plant is now taken into consideration and studied from every possible standpoint. . . .

In a paper on places of interest near her Columbus home, Mrs. Kellerman described a field trip on 9 July 1899 to Cantwell Cliffs and Rock Bridge in Hocking County.[77] She and Dr. Kellerman were delighted with the scenery, and they obtained plants for the State Herbarium and for their garden. Among their specimens that remain in the Herbarium is *Hackelia deflexa* (Wahlenb.) Opiz, a very rare disjunct northern species which was not identified for Ohio until very recently (Cooperrider 1982). The data for this specimen are: "Hocking Co.: Cantwell Cliffs, 9 July 1899, *W. A. & Mrs. Kellerman*," (OS 32632).

BOTANICAL PURSUITS IN OHIO

While in Ohio, Mrs. Kellerman worked with her husband on various botanical projects. A revision of his *Elements of Botany* (1883) appeared under the title *A Text-Book of Elementary Botany* (1897), to which was added a *Spring Flora* (1898) of Ohio. This expanded edition went through two reprintings, and in his preface the author acknowledged his wife's continued assistance.

Prof. Kellerman was engaged in expanding the general knowledge of the state's flora. Together, he and his wife collected specimens for the State Herbarium, which he had founded and was developing within the Department of Botany (Stuckey 1982, 1984). Their study of the non-indigenous vascular plants of Ohio was published by two organizations (Kellerman & Kellerman 1900). This checklist summarized known information on the geographical sources, longevity, survival status, and abundance of 430 foreign species. It was of fundamental importance in providing base-line data which all subsequent historical studies of plant invasions into Ohio have had to take into account. A short notice describing this paper appeared in the *Asa Gray Bulletin* (Anonymous 1900). The paper was Mrs. Kellerman's last substantial botanical publication and her major contribution to the knowledge of the flora of Ohio.

Mrs. Kellerman was one of five women who were charter members of the

Ohio Academy of Science, formed in 1891. For the next ten years, she was active in the Academy, served as vice-president in 1894 and 1901, and presented papers almost yearly, primarily on the subject of morphological variation in plants. The seven papers that she is known to have read at the annual meetings are listed in Appendix II. In 1897, at the annual meeting of the National Science Club held in Washington, DC, Mrs. Kellerman was elected president for the ensuing year (Anonymous 1897).

PUBLIC SERVICE, TRAGEDY, FAMILY, EVALUATION

In later years in Columbus, Mrs. Kellerman turned her energies to club work. She was the Ohio delegate to the Women's National Science Club, an organization which she helped found. As the state "chairman" for Ohio, she worked long and hard for the George Washington Memorial Association, which collected pennies from school children to aid in establishing George Washington University (Swingle 1939, 1953).

On 8 March 1908, William A. Kellerman died of "pernicious malarial fever" in Zacapa, Guatemala, while on a plant collecting expedition (Griggs et al. 1908, Osborn 1908, Lowden 1970). Following this tragic event, Mrs. Kellerman apparently did no additional significant botanical work. However, in an issue of *Science* later that year, she published an editorial defense of the teaching of trades in public schools and universities.[80] Earlier she had urged that, since young women should be taught to work and keep house, courses should be developed in the general educational curriculum to prepare them for this walk of life.[64]

To the Kellermans were born three children: Ivy (1877- ?), born in Oshkosh, Wisconsin, married Edwin C. Reed (? -1948); Karl Frederick (1879–1934), born in Göttingen, Germany, married Gertrude Hart; and Maude (1888–1992), born in Manhattan, Kansas, married Walter Tennyson Swingle (1871–1952). Karl F. Kellerman and Walter Swingle both distinguished themselves as botanists with the Bureau of Plant Industry of the United States Department of Agriculture (Humphrey 1961). Ivy Kellerman Reed, who studied abroad and took a Ph.D., specialized in comparative philology and gained international recognition as an authority on Esperanto grammar. She was admitted to the bar in Washington, DC (Swingle 1953, 1964). Maude Kellerman Swingle was educated at The Ohio State University and abroad, then worked as a librarian in the United States Department of Agriculture, Washington, DC, and later for the California Historical Society, San Francisco (Swingle 1939, 1953, 1964). She lived in San Francisco until her death 2 May 1992, just four days short of her 104th birthday.

Mrs. Kellerman believed that viewing flower and vegetable catalogs, and planning and working in gardens, was excellent mental therapy.[48] Today some of the better psychiatric hospitals have put these ideas into practice. Her philosophy is perhaps best stated in her own words at the end of an article entitled "Our roses."[66]

> There is nothing which exerts a finer influence on the habits of children than the care and cultivation of flowers; teach them to cultivate and preserve, rather than to ruthlessly destroy . . . The more we are among plants, and the more we understand about them, the great beauty we perceive in them, and the less the desire to injure them. It is an old adage that familiarity breeds contempt, but this is not so in connection with plants and flowers; on the contrary, we guard them more jealously and fondle them with greater care.

After an active life as a homemaker, botanist, and public service worker, Stella Kellerman died on 21 July 1936 in San Diego, California. Of Mrs. Kellerman's contributions to botany, Katharine D. Sharp (1913, p. 99), in her chapter on the activities of women botanists in Ohio, wrote:

> The botanical work, and especially the scientific articles by Mrs. Kellerman, place her in the foremost rank of Ohio botanists. She has assisted in her husband's work, including nearly all his publications, and has been a constant contributor for several years to periodicals devoted to natural science.

IDEAS ON THE ORIGIN OF CORN

Mrs. Kellerman published an abstract (1894)[27] and two short papers (1894, 1895)[34, 35] on the origin of corn. The first paper, written anonymously in *Vick's Illustrated Monthly Magazine* (1894)[34], and the second one, identified with her name, in *Meehan's Monthly* (1895)[35], are both essentially reports on the same phenomenon with similar wording in many of the sentences; accordingly, the first paper is also considered to have been written by Mrs. Kellerman. It is prepared with more detail than the somewhat abridged one in *Meehan's Monthly*, although the latter is the only one that has been cited by present-day investigators (Doebley 1983, 1984; Iltis in references cited below).

In abnormal specimens of the corn plant, Mrs. Kellerman noticed that the central or main stem of the tassel may produce pistillate flowers at its base that mature into grains on small ears. These flowers are surrounded by small spikes bearing functional staminate flowers with pollen towards the tip. To her, these abnormal ears suggested a reversion to former conditions, or a more or less ancestral bisexual inflorescence type. Through natural selection on these primitive forms, the pistillate flowers became more developed and more numerous, while at the same time, the staminate flowers became fewer and fewer in number until finally they were no longer produced on these branches. The central axis of the tassel upon enlarging became the cob, the entire structure becoming the ear of corn (Fig. 6). Mrs. Kellerman also described changes in the branches in which the internodes became shorter creating the shank of the ear, the sheaths were converted into husks covering the ear, and in the tassel at the top of the main stalk, staminate flower development prevailed with a simultaneous elimination of pistillate flowers. She attributed these changes to a long period of time and long-continued cultivation of the plant by native peoples in the Western Hemisphere.

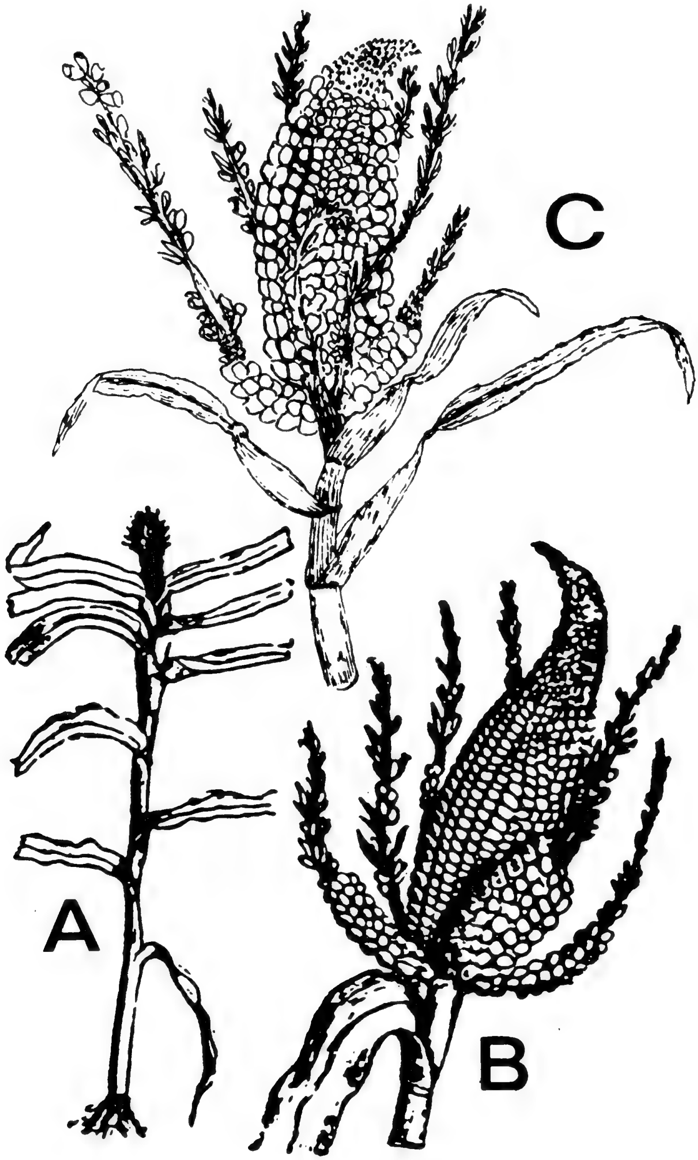

FIGURE 6. Illustrations of abnormal inflorescences of the corn plant drawn by Mrs. Kellerman. (A) Stalk or sucker with an ear at the top; (B) and (C) Tassel showing central axis that is partially developed into an ear. Figures A and B are from her article in Vick's Illustrated Monthly Mag. 18: 19. 1894. Figure C is from Meehan's Monthly 5: 44, 53. 1895.

Mrs. Kellerman is currently given credit as being the first investigator who, in her papers of the early 1890's[27, 34, 35], pointed out that the present-day ear of the corn plant is the counterpart or homolog to the central spike of the tassel. This interpretation was noted by Weatherwax (1918) and later adopted by Mangelsdorf and Reeves (1939, p. 55) and Mangelsdorf (1945). As Mangelsdorf (1974, p. 7) further commented, Mrs. Kellerman and the other early investigators did not explain the morphological nature or evolutionary significance of these features. The most recent idea on the evolution of corn, the Catastrophic Sexual Transmutation Theory, as proposed by Iltis (1970, 1981a, b, 1983a, b, 1984, 1987), states that the ear of corn is the transformed, slender, feminized, condensed central spike, or tassel, which terminates the primary lateral branches, of the annual Mexican teosinte plant. Iltis (1983) further remarked that Mrs. Kellerman's maize ear-central tassel spike homology hypothesis differs in that the ear of corn is not derived from the polystichous tassel of the corn plant as published by her, but rather, according to Iltis, the ear has originated from a central distichous spike in the tassel of teosinte.

CONCLUSION

As a botanist, Mrs. William A. Kellerman can be considered a part of that group of women who were an important, but overlooked constituency of individuals belonging to the botanical community in the last decade of the nineteenth century. At this period, according to Rudolph (1982), botany was thought to be a suitable study for young women in schools as an amateur avocation. Women who engaged in scientific work throughout most of the nineteenth century were on the periphery of the scientific community (Kohlstedt 1978).

Mrs. Kellerman belongs to that group of women who were married to professional botanists, had children, and mainly achieved their contributions as part of their husband's accomplishments, as discussed by Slack (1987). From what meager information is known, as discussed in this paper, Mrs. Kellerman had very little professional training. Even though she assisted her husband in his botanical writing, her financial support came from her husband's adequate salary as a Professor in a growing and developing university, as The Ohio State University was at that time. Mrs. Kellerman also was an independent investigator, who made observational studies upon which she prepared her own manuscripts or short notes and published them separately from her husband. Among the most important topics were her studies on the origin of Indian corn, morphological variations in the leaves of trees, and culture of garden plants. These studies were published mostly as short notes in the more general science or popular gardening periodicals rather than those standard journals supported by professional botanists or botanical societies.

While some women of this period, who became widows, continued their botanical work or turned their life into an even more productive, indepen-

dent scientific career, Mrs. Kellerman did not proceed in that manner. After her husband's death, she is not known to have published any papers in botany. It seems clear that her motivation, energy, and support had come from her husband. Although the reasons for Mrs. Kellerman's not continuing to pursue her research in botany are not known, the lack of a formal botanical education probably would have prevented her from obtaining a college or university position, had she held that desire. Furthermore, as she entered her fifties, perhaps her interests were changing. Only two of her botanical notes are known to have been published after 1900, and evidence shows that other interests were developing, as she had become involved in leadership roles of at least two national club organizations. In retrospect, Mrs. Kellerman left a fine legacy of botanical and horticultural observations, which investigators of the twentieth century have little noticed. With the inclusion of her extensive bibliography (Appendix I), botanists of future generations now have access to Mrs. Kellerman's publication record and will be able to explore more extensively some of the topics about which she wrote.

ACKNOWLEDGMENTS

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The libraries of the following institutions were consulted in the preparation of Mrs. Kellerman's bibliography: Cornell University, Missouri Botanical Garden, and The Ohio State University.

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APPENDIX I. PUBLISHED CONTRIBUTIONS OF MRS. W. A. KELLERMAN

1. 1887. The Kansas forest trees identified by leaves and fruit. Trans. Kansas Acad. Sci. 1885–1886 10: 99–111. (With William A. Kellerman, first author.)
2. 1888. Analytical Flora of Kansas. Published by the authors, Manhattan, KS. 197 pp. (With William A. Kellerman, first author.)
3. 1890. Evolution in leaves. Trans. Kansas Acad. Sci. 1889 12: 168–173. 38 illus.
4. 1891. Indications of evolution in leaves. Science 18: 226–227.
5. 1892. Some curious catnip leaves. Science 19: 66–67.
6. A series of abnormal *Ailanthus* leaflets. Science 19: 90–91.
7. A seedling blackberry plant. Science 19: 94–95.
8. The specialist [on the progress of science]. Science 19: 161–163.
9. 1893. Leaf-variation—its extent and significance. J. Cincinnati Soc. Nat. Hist. 16: 49–53 + pl. II. Read at the annual meeting of the Ohio State Academy of Science, 1892.
10. Significance in leaf variation. Meehan's Monthly 3: 4. illus.
11. Seedless fruit [persimmons]. Meehan's Monthly 3: 21.
12. Evolution of the leaves of the cinquefoil or common fivefinger [Potentilla canadensis]. Meehan's Monthly 3: 37–38. illus.
13. Fibre plants [Hibiscus moscheutos]. Meehan's Monthly 3: 57.
14. Variation of the horse-radish leaves. Meehan's Monthly 3: 67. [Line drawing of the leaves], p. 77.
15. Stipules of rose leaves. Meehan's Monthly 3: 148. illus.
16. The survival of the fittest. Meehan's Monthly 3: 150.
17. Letters to the editor. Snake story [concerning Karl Kellerman and a snake in captivity that gave birth to young]. Science 21: 36–37.
18. Epidemic forms of mental or nervous diseases or disorders. Science 21: 305.
19. Letters to the editor. Animal vocabularies. Science 22: 123.
20. Letters to the editor. The cackle of hens. Science 22: 152.
21. Letters to the editor. A small tragedy [concerning a captured spotted snake that ate a smaller snake]. Science 22: 152.
22. Ohio Experiment Station greenhouses. Vick's Illustrated Monthly Mag. 16: 53.
23. A wee garden spot [on an outdoor garden in Lexington, Kentucky]. Vick's Illustrated Monthly Mag. 16: 68.
24. 1894. Variations in leaves [horse-radish]. Meehan's Monthly 4: 84–85. illus.
25. Crested Aspidium acrostichoides. Meehan's Monthly 4: 144. illus.
26. Sheathing petioles and stipules [Heracleum lanatum]. Meehan's Monthly 4: 164.
27. The evolution of Indian corn [abstract]. Annual Rep. Ohio State Acad. Sci. 2: 32–33. Read at the annual meeting of the Academy, 1893.
28. Leaf variation. Vick's Illustrated Monthly Mag. 17: 84–85. illus.
29. Does nature make mistakes? [concerning shells of nuts] Vick's Illustrated Monthly Mag. 17: 170.
30. The first cooperative society [coevolution of insects and plants]. Vick's Illustrated Monthly Mag. 17: 178–179. illus.
31. In my garden. Vick's Illustrated Monthly Mag. 17: 188. illus.
32. Trays for flower pots. Vick's Illustrated Monthly Mag. 18: 2.

33. Leaf variations [blackberry]. Vick's Illustrated Monthly Mag. 18: 10. illus.
34. The probable differentiation of the ear and tassel in the indian corn. Vick's Illustrated Monthly Mag. 18: 19.
35. 1895. The primitive corn. Meehan's Monthly 5: 44, 53. illus.
36. Origin of the Kalmia pockets. Meehan's Monthly 5: 65–66.
37. Decorating and utility combined [growing wandering jew in water glass containers]. Vick's Illustrated Monthly Mag. 18: 95.
38. Vick's dollar collection of bulbs. Vick's Illustrated Monthly Mag. 18: 96.
39. Tendrils. Vick's Illustrated Monthly Mag. 18: 121. illus.
40. Our common molds. Vick's Illustrated Monthly Mag. 18: 150–151. illus.
41. The development of the pinnate from the simple leaf. Vick's Illustrated Monthly Mag. 18: 136–137. illus.
42. 1895–1896. A sketch of the life of Linnaeus. Vick's Illustrated Monthly Mag. 19: 21, 35–36.
43. 1896. Bees and clover. Meehan's Monthly 6: 63.
44. Some rare leaves of Liriodendron tulipifera. Meehan's Monthly 6: 104–105. illus.
45. Adnate stipules in leaves of Liriodendron. Meehan's Monthly 6: 145. illus.
46. No time for house plants. Vick's Illustrated Monthly Mag. 19: 69.
47. Variations of leaves on the same plants [Sassafras]. Vick's Illustrated Monthly Mag. 19: 89. illus.
48. An afternoon with Mrs. Snooks [on how to have better mental health by working in a garden]. Vick's Illustrated Monthly Mag. 19: 99–100.
49. My gladioli, tulips, etc. Vick's Illustrated Monthly Mag. 19: 123.
50. The cleome. Vick's Illustrated Monthly Mag. 20: 29. illus.
51. 1897. The construction of the dogwood flowers. Meehan's Monthly 7: 83–85. illus. Read at the annual meeting of the Ohio State Academy of Science, 1896.
52. Freaks in flowers [nasturtiums]. Meehan's Monthly 7: 205–206. illus.
53. The dahlia. Vick's Illustrated Monthly Mag. 20: 74. illus.
54. A talk about the dandelion. No. 1. Vick's Illustrated Monthly Mag. 20: 109. illus.
55. A talk about the dandelion. No. 2. Vick's Illustrated Monthly Mag. 20: 126. illus.
56. Relationship of birds and reptiles [on the fossil Archaeopteryx]. Vick's Illustrated Monthly Mag. 20: 139.
57. A talk about the dandelion. No. 3. Vick's Illustrated Monthly Mag. 20: 142. illus.
58. A bit of summer [on humming-bird and bumble-bee extracting nectar from honeysuckle]. Vick's Illustrated Monthly Mag. 20: 160.
59. 1898. A double trillium. Asa Gray Bull. 6: 19–20.
60. The blackberry as an ornamental shrub. Meehan's Monthly 8: 10.
61. Leaf variation [Liriodendron]. Meehan's Monthly 8: 68.
62. Fasciated branches [thistle]. Meehan's Monthly 8: 100.
63. Dissection of a double trillium [abstract]. Annual Rep. Ohio State Acad. Sci. 6: 39–40. Read at the annual meeting of the Academy, 1897.
64. A word for the girls [on practical education and the art of housekeeping]. Vick's Illustrated Monthly Mag. 21: 43.
65. Insects and a sprayer [on keeping outdoor plants free of pests]. Vick's Illustrated Monthly Mag. 21: 125.
66. Our roses. Vick's Illustrated Monthly Mag. 21: 130.
67. Observations [of leaf variation] on a hop vine. Vick's Illustrated Monthly Mag. 21: 141. illus.
68. First flowers of spring [crocus]. Vick's Illustrated Monthly Mag. 21: 155. illus.
69. The doubling of flowers [hollyhock]. Vick's Illustrated Monthly Mag. 21: 170. illus.
70. 1899. Fruit and flowers at the same time [on a pear tree]. Meehan's Monthly 9: 7.
71. The Chinese primrose [Primula sinensis]. Vick's Illustrated Monthly Mag. 22: 127. Signed "Mrs. W. A. C."
72. 1900. The non-indigenous flora of Ohio. J. Columbus Hort. Soc. 15: 30–54. (With William A. Kellerman, first author.) Also printed in the Bull. Ohio State Univ., ser. 4, 27 (Bot. Ser. 4): 1–28. Read at the annual meeting of the Ohio State Academy of Science, 1899.
73. Linaria cymbalaria. Meehan's Monthly 10: 40.

74. Ampelopsis cordata. Vick's Illustrated Monthly Mag. 23: 101–102, incl. a photograph of plant on north side of the Kellerman home in Columbus.
75. Winter hanging baskets [on Linaria cymbalaria and its escape from cultivation and establishment in the lawn habitat]. Vick's Illustrated Monthly Mag. 23: 103.
76. A. A. A. S. [about the meeting of the American Association for the Advancement of Science, held 21–23 August 1899 at The Ohio State University, Columbus]. Vick's Illustrated Monthly Mag. 23: 141.
77. Places of interest near home [account of a day's journey to Cantwell Cliffs and Rock Bridge, places of botanical interest in Hocking County, Ohio]. Vick's Illustrated Monthly Mag. 23: 165–166, incl. a photograph of each locality.
78. 1902. Bloodroot. Vick's Illustrated Family Mag. 26(1): 2.
79. 1903. Plant growth and evolution. Vick's Illustrated Family Mag. 26(12): 1.
80. 1908. Education and the trades. Science 28: 683–684.

APPENDIX II. PAPERS PRESENTED BY MRS. W. A. KELLERMAN TO THE OHIO STATE ACADEMY OF SCIENCE

1892. Leaf variation: its extent and significance. Presented at the first annual meeting, 29–30 December, Columbus. (See Appendix I, 9.)
1893. Evolution of Indian corn. Presented at the second annual meeting, 28–29 December, Columbus. (See Appendix I, 27.)
1894. Note on the variation of Leriodendron [sic] leaves. Presented at the third annual meeting, 27–28 December, Columbus. (See Appendix I, 44.)
1896. Note on Cornus florida. Presented at the sixth annual meeting, 29–30 December, Columbus. (See Appendix I, 51.)
1896. Some interesting leaf variations. Presented at the sixth annual meeting, 29–30 December, Columbus.
1897. Dissection of a double Trillium. Presented at the seventh annual meeting, 28–29 December, Columbus. (See Appendix I, 63.)
1899. The non-indigenous flora of Ohio. (With W. A. Kellerman, first author.) Presented at the ninth annual meeting, 22–23 December, Cleveland. (See Appendix I, 72.)

ANNOUNCEMENT

OAK SAVANNA CONFERENCE

The United States Environmental Protection Agency has announced the dates and format for the Oak Savanna Conference. It is scheduled for 18–20 February 1993. The first two days will take place at EPA Region 5 offices in Chicago while the conference moves to Northeastern Illinois University (also in Chicago) for the third day.

This meeting will concentrate on many aspects of the oak savanna ecosystem, including (but not limited to) research, management, restoration, education, and public participation. Participants will be attending seven sessions during the first two days. The third day is open to the general public and will be a mix of workshops and paper sessions similar to the model used in North American prairie conferences. An overview of the results of the sessions held during the first two days will also be provided.

For additional information about the conference, please direct any inquiries to: Milo Anderson, ME-19J or Karen Holland, WCP-15J at the U.S. Environmental Protection Agency, Region 5, 77 West Jackson, Chicago, IL 60604.

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DISTRIBUTION AND HABITATS OF THE FORKED ASTER (ASTER FURCATUS: ASTERACEAE), A THREATENED WISCONSIN PLANT

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ABSTRACT

An analysis of soil characteristics in Wisconsin populations of *Aster furcatus* was conducted in conjunction with efforts to develop suitable transplantation procedures for this threatened species. We were unable to identify any combination of soil or plant community characteristics capable of differentiating forked aster sites or which could be related to its rarity. The soil pH of *A. furcatus* sites is consistently alkaline, and there is a tendency towards higher levels of nitrogen and lower levels of available potassium than those of similar sites that do not support the species. We attribute the rarity of *A. furcatus* more to factors of competition and genetic impoverishment than to the lack or loss of specialized habitat. Forked aster sites are associated with moderate disturbance and minimal apparent competition.

INTRODUCTION

In 1988, we began a study of the biology of forked aster (*Aster furcatus* Burgess, Asteraceae) to aid efforts aimed at the transplantation of a population (Sheboygan Falls, Sheboygan Co., Wisconsin) which would otherwise be destroyed by highway construction. *Aster furcatus* is a true midwestern endemic (Jones 1987). The species is presently listed as threatened in Wisconsin (Wisconsin Department of Natural Resources 1989) and is rare in every state in which it has been recorded (Fig. 1). Forked aster is a "Category 2" candidate for the United States Endangered and Threatened Species List (U.S. Department of Interior 1990). As a part of our research, we examined habitat characteristics of Wisconsin *A. furcatus* populations to identify specific habitat requirements of the species. We also wanted to

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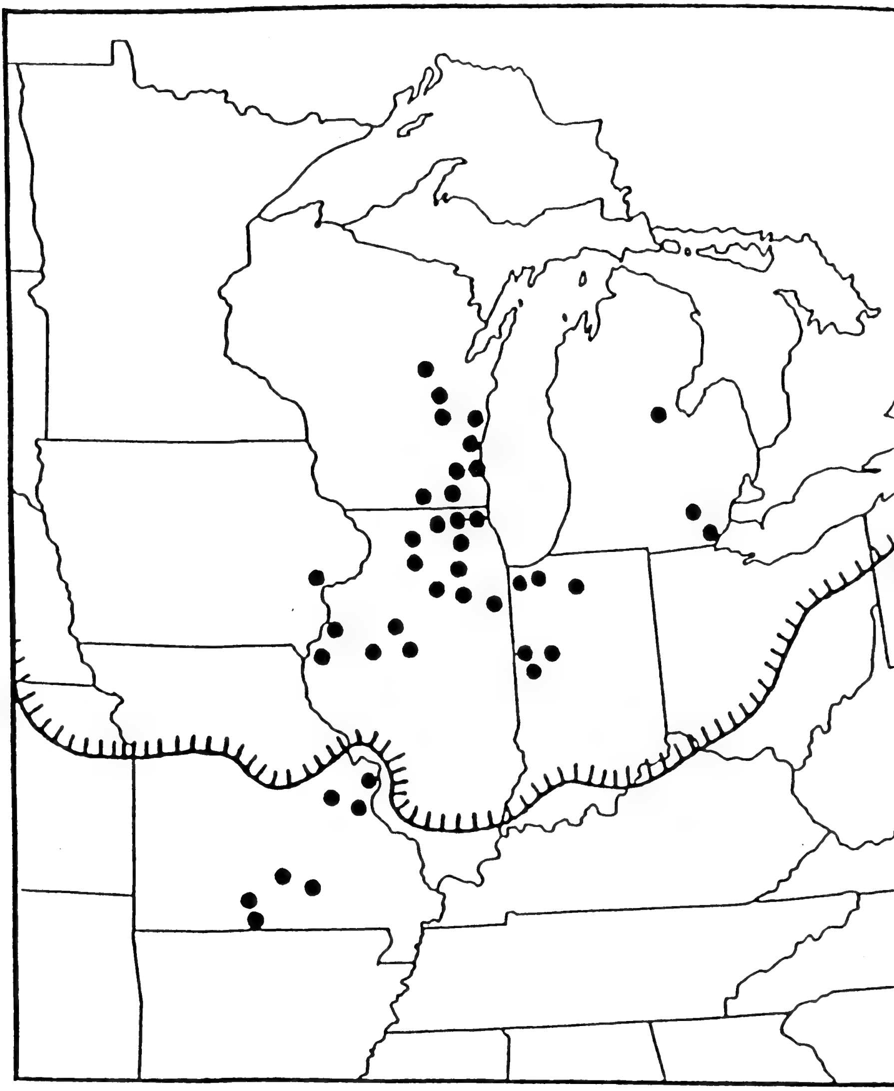

FIGURE 1. Historical North American distribution of *Aster furcatus* based on specimen data provided by W. Lamboy. Hatched line represents the maximum extent of Pleistocene glaciation.

compare the habitat characteristics of existing *A. furcatus* populations with several possible transplant sites.

The habitat characteristics of the forked aster had not previously been examined in any detail. Tans and Read (1975) earlier emphasized that ". . . much needs to be learned about the life history of this elusive regional

endemic." Because of their bearing on many life-history aspects, the acquisition of "critical habitat" data is surely one of the most fundamental elements of species conservation programs.

Aster furcatus has a wide distribution, but very localized and scattered populations. The greatest "stronghold" of surviving forked aster populations is in Missouri, where it is found almost exclusively in cool, damp microhabitats of north-facing, dolomite limestone bluffs and talus slopes along rivers. Thirty of the 37 known *A. furcatus* sites in Missouri, however, are confined to a single county along a 75 km stretch of the Jacks Fork River (Missouri Department of Conservation 1989). In all, there are only six county occurrences of the species in Missouri, with 85% of the sites located within two adjacent counties. The large number of Missouri sites actually provides a somewhat exaggerated picture of its abundance because it is so localized in the state.

In Indiana, Illinois, and Wisconsin, forked aster grows in a wider variety of habitats including rich floodplain woods (where it is most commonly found), woodland edges, disturbed woodlots, railroad rights-of-way, eroding north-facing slopes, and dry oak-hickory forests (Jones 1987, Tans & Read 1975). The decline of forked aster in Illinois is illustrated by the failure to relocate many of the state's historical populations (Jones 1987). Wisconsin contains the largest number of occurrences for the species among the glaciated states, with 15 populations currently documented. Three of these were first collected at their present locations in 1874, 1904, and 1908, and two were first collected between 1910 and 1930. Three more localities have been known for at least 40 years. A number of populations (many in Milwaukee Co.), however, have been destroyed by development.

Aster furcatus is a perennial herb that spreads clonally by shallow rhizomes. As indicated above, *A. furcatus* populations can persist at some sites for prolonged periods, probably as very long-lived clones. Rhizomes, up to 50 cm long, are formed late in the growing season and produce a terminal vegetative or reproductive shoot the following season (Reinartz & Les unpubl.). Flowering and seed set are more abundant in sunny microsites. Reproduction by seed is a rare event because the seedlings grow very slowly, are intolerant of competition, require open, relatively fertile soils, and will not tolerate dense shade (Reinartz & Les unpubl.).

Aster furcatus possesses extremely low levels of genetic variation throughout its range. Les et al. (1991) examined electrophoretic variation in 23 populations across the range of the species (Wisconsin, Illinois, Indiana, Missouri) and found that most of surveyed genetic loci were fixed for single alleles. We hypothesize that *A. furcatus* may be a relatively recently evolved species that has been characterized by reduced genetic variation since its inception.

The survival of forked aster is highly influenced by aspects of its breeding system and reproductive biology. Species in the composite family are typically outcrossers due to the presence of a genetic incompatibility system. The sporophytic incompatibility system of *Aster furcatus* requires a minimum of four alleles for compatible crosses (and therefore seed-set) in popu-

lations. We believe that bottlenecks associated with the founding of many populations have greatly depleted pools of incompatibility alleles, thereby reducing the full potential seed set of individuals (Les et al. 1991). In some instances, populations appear to retain fewer than four alleles required for minimal seed set. Crossing studies have demonstrated that some individuals of forked aster have evolved self-compatibility, which enables seed set in populations where compatible mates are scarce or few (Reinartz & Les unpubl.). Such breakdowns in self-incompatibility must surely result in heightened levels of inbreeding in forked aster populations.

This study provides a further contribution to the biology of *Aster furcatus* with a report on habitat characteristics of Wisconsin populations of this threatened plant.

MATERIALS AND METHODS

We selected nine Wisconsin *Aster furcatus* populations (which seemed to span the full range of habitats) for study of site characteristics. Three additional sites were selected which resembled existing *A. furcatus* sites in topography and general vegetation characteristics, but which did not presently support populations of the species (Cato Falls, Kewaskum, and Greenbush). These three areas were selected as potential transplant sites for relocation of the Sheboygan Falls population which was threatened by a highway construction project.

Dominant species in the tree stratum of each site were recorded. Soil types were described using Soil Conservation Service manuals. The number of stems of *Aster furcatus* was estimated visually at eight sites, and was based on a previous quantitative survey (Les et al. 1991) for the Kletzsch Park site. Five soil samples were collected from each of the 12 sites, and were analyzed for 12 characteristics (see Table 3). Analyses were performed by the University of Wisconsin-Milwaukee Soils Laboratory.

At both the *Aster furcatus* sites and proposed transplant sites, we tested for significant differences among the soil factors using a one-way analysis of variance (ANOVA). We then analyzed soil variables for significant differences between *A. furcatus* sites and proposed transplant sites using a nested ANOVA. Analyses of variance were performed using the SPSS-PC+ software package (SPSS 1988).

Ten soil variables, measured on samples from the nine *Aster furcatus* sites and the three potential transplant sites, were standardized so that each variable had a mean of 0 and a standard deviation of 1. The percent clay was arbitrarily excluded from this analysis because it would be redundant to include more than two of the three soil texture percentage categories in an ordination (any third percentage value is simply the sum of the other two subtracted from 100). We then performed a "detrended correspondence analysis" (DECORANA) of the data set (Hill 1979) to ordinate the twelve sites in multidimensional soil variable space. We plotted the first and second axes of the DECORANA in order to judge which sites were most similar in the 10-dimensional soil variable space.

RESULTS

The nine *Aster furcatus* sites differed considerably with respect to their dominant tree canopy species (Table 1) and general soil types (Table 2). Only two tree species (red and white oak) dominated at more than 50% of the sites (Table 1). Soil characteristics varied among sites (Table 3), with significant differences ($p < 0.01$) occurring for each variable except cation exchange capacity ($p > 0.4$). *Aster furcatus* sites differed significantly from

TABLE 1. Dominant canopy species in nine Wisconsin *Aster furcatus* sites. 1 = Sheboygan Falls, 2 = Greendale, 3 = Cambridge, 4 = Perkins, 5 = Lauderdale Lakes, 6 = Kletzsch Park, 7 = Jacobus Park, 8 = Roehl Co. Park, 9 = Whitnall Park.

canopy species	sites 1	2	3	4	5	6	7	8	9	total sites
Acer saccharum Marshall	X					X				2
Acer negundo L.		X						X	X	3
Carya ovata (Miller) K. Koch					X					1
Fagus grandifolia Ehrh.	X									1
Fraxinus nigra Marshall									X	1
Fraxinus pensylvanica Marshall		X		X						2
Juglans nigra L.								X		1
Pinus strobus L.	X									1
Prunus serotina Ehrh.				X						1
Quercus alba L.			X	X	X	X		X		5
Quercus bicolor Willd.									X	1
Quercus macrocarpa Michaux									X	1
Quercus rubra L.	X		X		X	X	X	X		6
Quercus veluntina Lam.				X						1
Tilia americana L.	X		X						X	3
Ulmus americana L.				X						1

proposed transplant sites in three of the measured variables (pH, water soluble nitrate nitrogen, and available potassium), and two other variables (% silt, soluble salts) were nearly significant (Table 4). Detrended correspondence of the 12 sites based on soil characteristics showed that Lauderdale Lakes was the most unusual site for *Aster furcatus* (Fig. 2). Lauderdale Lakes was unusually high in soluble salts and low in available potassium (Table 3, Fig. 2) compared to other forked aster sites. The three non-*Aster* sites grouped with the Roehl Co. Park, Sheboygan Falls, and Whitnall Park *Aster* population sites (Fig. 2). Although the non-*Aster* sites did not form a completely separate group distinct from the forked aster sites, they did define one extreme for the multivariate set of soil characteristics. This location in the ordination is based primarily on the low pH, low nitrogen, high potassium, and high organic matter content of the non-*Aster* sites (Table 3, Fig. 2).

TABLE 2. Soil types and estimated abundance of *Aster furcatus* individuals (stems) at nine Wisconsin sites (*data from quantitative survey in Les et al. 1991).

site	soil type	# stems
Cambridge	Kewaunee-Manawa association	400
Greendale	Alluvial land	4,000
Jacobus Park	Ozaukee-Morley-Mequon association	500
Kletzsch Park	Fox-Casco association	2,900*
Lauderdale Lakes	Casco/Casco-Rodman complex	2,000
Perkins	Fox sandy loam	2,000
Roehl Co. Park	Edmond-Rockton-Whalen association	100
Sheboygan Falls	Bellevue fine sandy loam	2,000
Whitnall Park	Sebewa silt loam	300

TABLE 3. Soil characteristics of nine Wisconsin *Aster furcatus* populations and three proposed transplant sites (*). Results are the mean (± 1 SD) of five samples (except CEC based on 1-5 samples; ** = single sample). Values from ANOVA were significant ($p < 0.01$) for every variable except CEC (means followed by same lower case letters did not differ significantly). ORG = organic matter, SS = soluble salts (mhos $\times 10^{-5}$), P = parts per million (ppm) available phosphorus, K = ppm available potassium, Ca = ppm available calcium, Mg = ppm available magnesium, N = ppm water soluble nitrate, CEC = cation exchange capacity (meq/100g).

population	habitat	% sand	% silt	% clay	pH	% ORG	SS	P	K	Ca	Mg	N	CEC
Sheboygan Falls	floodplain	44(9)b	45(9)cde	11(1)abc	7.3(0.2)fg	9.3(4.9)bcde	17(4)ab	12(4)ab	118(40)abcd	1940(890)cd	485(79)def	66(17)bc	29.8(14.2)
Greendale	floodplain	50(21)bc	41(16)bcd	9(5)ab	7.2(0.2)def	5.1(0.8)ab	20(2)abc	9(5)a	121(44)bcde	1285(246)ab	445(10)bcd	66(7)bc	22.4(3.7)
Cambridge	floodplain	45(6)b	44(8)cde	10(5)abc	7.4(0.1)g	4.8(1.1)ab	23(3)abc	13(1)abc	176(32)e	1330(145)ab	400(16)ab	99(8)e	24.4(1.5)
Perkins	woods	71(2)d	24(2)a	5(1)a	7.1(0.2)cde	5.2(0.8)ab	19(3)ab	28(5)e	109(22)abc	1200(197)a	418(28)abc	73(12)cd	28.2(3.2)
Lauderdale Lakes	woods	26(5)a	45(14)cde	28(9)f	7.0(0.2)bc	7.7(3.0)abcd	51(33)d	10(4)a	62(31)a	1565(268)abc	529(48)f	42(41)ab	49.2(38.4)
Kletzsch Park	floodplain	69(5)d	23(3)a	9(5)ab	7.3(0.1)efg	7.2(1.1)abc	34(5)c	15(1)bcd	133(60)bcde	2050(592)cd	469(16)cde	72(12)cd	37.1**
Jacobus Park	bluff	61(15)cd	28(11)ab	11(4)abc	7.1(0.1)cde	4.4(1.5)a	27(5)bc	14(3)abc	247(53)f	1265(325)ab	383(37)a	68(23)c	8.1**
Roehl Co. Park	floodplain	24(4)a	55(6)ef	21(8)de	7.1(0.2)cd	4.6(1.3)ab	19(7)ab	13(2)ab	89(10)ab	1305(99)ab	449(38)bcd	31(4)a	28.8(2.7)
Whitnall Park	floodplain	26(3)a	51(17)def	16(3)cde	7.2(0.1)def	12.7(5.2)e	23(8)abc	14(2)abc	258(24)f	1705(165)bcd	538(27)f	95(34)de	–
MEAN		46(20)	40(15)	13(8)	7.2(0.2)	6.8(3.6)	26(15)	14(6)	146(73)f	1516(474)	457(62)	68(28)	30.0(17.8)
Cato Falls*	floodplain	43(2)b	35(6)abc	22(6)ef	6.8(0.2)a	6.5(0.4)ab	26(15)bc	19(4)d	274(94)f	1610(138)abcd	492(24)def	34(22)a	40.5**
Kewaskum*	woods	22(14)a	63(9)f	15(6)bcd	6.9(0.1)ab	12.3(8.0)de	10(10)a	15(4)bcd	174(13)de	1885(382)cd	514(61)ef	50(14)abc	53.5(4.4)
Greenbush*	floodplain	39(7)b	51(6)def	11(3)abc	7.0(0.1)bc	11.3(5.6)cde	30(4)bc	18(4)cd	158(46)cde	2080(401)d	600(84)g	53(12)abc	47.2(10.2)
MEAN*		34(13)	50(14)	16(7)	6.9(0.1)	10.0(5.9)	22(13)	17(4)	202(78)	1858(365)	535(75)	46(17)	49.3(7.5)

TABLE 4. Summary of nested ANOVA of 11 soil characteristics (abbreviations follow Table 3) compared between *Aster furcatus* ("aster") sites and proposed transplant ("transplant") sites.

soil variable	aster site mean	transplant site mean	Nested ANOVA's F [1,10]	significance
pH	7.22	6.88	15.55	$p < 0.001$
water soluble N	67.9	45.7	12.34	$p = 0.001$
available K	146	202	8.77	$p = 0.005$
% silt	39.6	49.5	3.64	$p = 0.062$
soluble salts	25.8	21.7	3.58	$p = 0.065$
available Mg	457	535	0.70	$p = 0.408$
available Ca	1520	1860	0.54	$p = 0.466$
% sand	46.2	34.4	0.43	$p = 0.513$
available P	14.3	17.3	0.18	$p = 0.670$
% clay	13.4	16.1	0.13	$p = 0.717$
% organic matter	6.8	10.0	0.03	$p = 0.858$

DISCUSSION

Aster furcatus populations in Wisconsin are frequently found along river or stream floodplain terraces (Table 3), however, they also exist in a wider variety of habitats. Tans and Read (1975) stated that, "This diversity in the quality of habitats from which the few collections of *A. furcatus* have been taken . . . is somewhat disconcerting to the botanist who would like to think (or hope) that all rare plants should be found in the most pristine habitats." Our field experiences in Wisconsin and Missouri corroborate this observation.

Although the species is often found beneath the canopy of woodland communities, its highest density is usually attained at semi-open sites (frequently a forest edge along a stream, field, or road). We have noticed that the growth of *A. furcatus* is generally good at sites with adequate light and moderate levels of disturbance, but is poorer at sites possessing a large diversity of other species which evidently compete with the aster. In a garden setting where light is abundant and competition is prevented by periodic weeding, the forked aster grows into robust specimens with good seed production (Reinartz & Les pers. obs.). The uncommon occurrence of natural habitats with both high light levels and low competition from other herbaceous species is undoubtedly related to the rarity of the forked aster. Forked aster appears to be tolerant of moderately disturbed sites associated with floodplains, roadsides, and bluffs.

In Wisconsin, forked aster generally is found in proximity of forests with oak and basswood canopies, and occurs on silty or sandy loams rather than heavy clay soils. The underlying parental material is limestone or calcareous glacial till with a slightly alkaline reaction (pH = 7.2). Apparently, forked aster does not grow in acidic soils. According to Curtis (1959), the Wisconsin forest community characterized by the highest average pH (7.0) is the

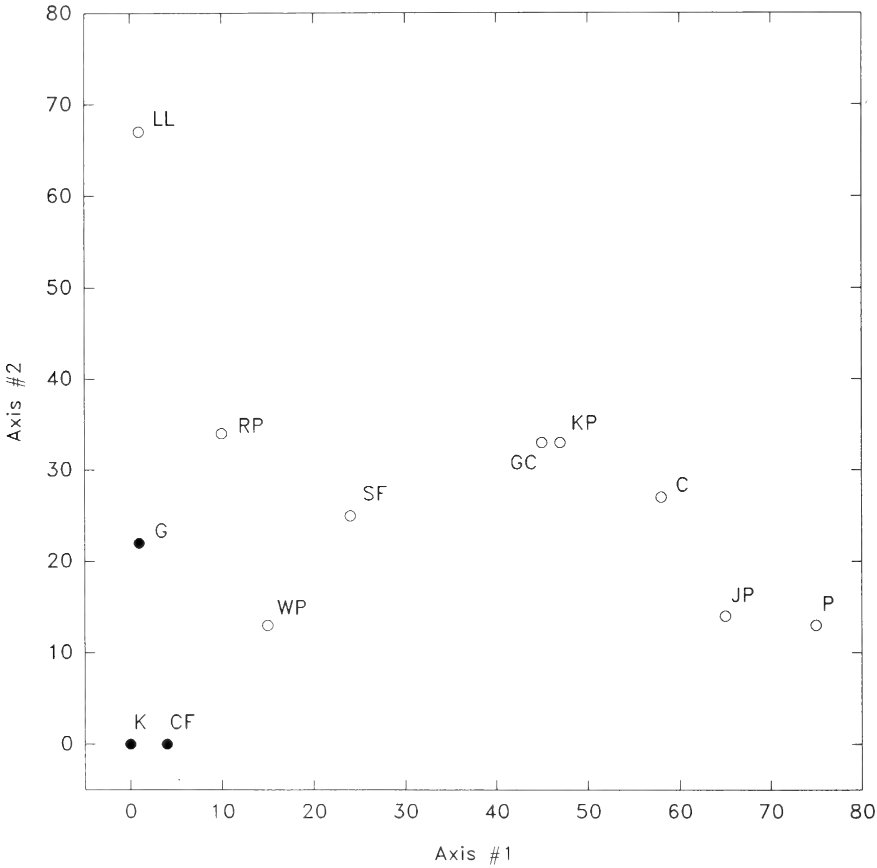

FIGURE 2. Result of detrended correspondence analysis (DECORANA) ordination based on 10 soil variables for nine *Aster furcatus* sites (open circles) and three sites lacking *A. furcatus* populations (closed circles). LL = Lauderdale Lakes, RP = Roehl Co. Park, GC = Greendale, KP = Kletzsch Park, SF = Sheboygan Falls, C = Cambridge, G = Greenbush, WP = Whitnall Park, JP = Jacobus Park, P = Perkins, K = Kewaskum, CF = Cato Falls.

southern wet forest type. All hardwood canopy species associated with forked aster (Table 1) are listed as average components of the southern lowland wet-mesic forest type (Curtis 1959).

The pH of *Aster furcatus* sites differed significantly from our proposed transplant sites, the latter averaging slightly acidic values (6.9). Of the nine *A. furcatus* sites examined, none was characterized by a pH less than 7.0. Although an alkaline pH may well be critical for survival of this species, it is

difficult to ascertain whether the association of *A. furcatus* and alkaline pH reflects its physiological tolerance or simply correlates with disturbance regimes that may typify the southern wet forest community type.

Two soil nutrients (nitrogen and potassium) showed significant differences between forked aster sites and proposed transplant sites. Both higher and lower values for each variable could be found among forked aster sites, however, an indication that neither low potassium nor high nitrogen is essential for occurrence of the species.

The composite family (Asteraceae) represents from 9–12% of the groundlayer species occurring in Wisconsin's southern wet forests (Curtis 1959). Consequently, competitive interactions may occur frequently among biologically similar species of the composite family.

Extensive site-to-site variability for all measured soil characteristics indicates that forked aster is not narrowly adapted to a specific combination of pedologic conditions. The habitats of *Aster furcatus* populations (i.e., floodplain, woods, or bluff) were related somewhat to soil characteristics in the sense that the three sites not located on river floodplains (Lauderdale Lakes, Jacobus Park, Perkins) defined the extremes of our site ordination plot based on soil variables (Fig. 2). This relationship emphasizes the extensive site-to-site differences that exist among forked aster populations in Wisconsin.

Overall, this study provides a characterization of typical habitat features of *Aster furcatus* sites encountered in Wisconsin. Of all soil factors examined, an alkaline pH was the most consistent variable associated with site occurrences. We did not, however, identify other soil factors as specific site requirements which could offer an explanation for its rarity. Similarly, the associated plant community was neither particularly unusual nor constant. From these observations, we conclude that the successful transplantation of forked aster plants to new sites does not require a meticulous match of soil conditions. We would recommend that transplant sites should possess a pH of 7.0–7.4 and generally resemble the habitat of nearby existing forked aster populations. Although floodplain habitats are reasonable sites for potential transplants of the species, our analyses indicate that suitable transplant sites may also be sought in wooded areas or on bluffs. The common occurrence of the species on north-facing slopes in the southern portion of its range (e.g. Illinois, Missouri) may indicate a requirement for cool site conditions.

We believe that the most critical habitat characteristic of the forked aster is a requirement for moderate levels of disturbance to periodically increase light levels necessary for enhancement of vegetative and reproductive vigor. The common occurrence of *A. furcatus* near streams and rivers may be the outcome of advantageous periods of disturbance related to flooding events. Any transplant site under consideration for the species should be selected to provide an appropriate level of disturbance. Overall, the rarity of *A. furcatus* is probably tied closely to its poor reproduction from seed and low levels of genetic variability. Consequently, sites which become opened by natural disturbances appear to offer the maximum potential for establishment and perpetuation of the species.

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HERACLEUM MANTEGAZZIANUM (GIANT COW PARSNIP): ANOTHER EXOTIC IN THE MICHIGAN FLORA

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On July 8, 1991, Shawn Bouterse, a student at Michigan State University, brought for identification to the Beal-Darlington Herbarium leaf and infructescence fragments from an unknown herb that stood "well over seven feet tall." Subsequently his parents, Gloria and Charles Bouterse, brought in additional pieces of the plant from their property northeast of Williamston, MI; more of the very large compound umbel and a leaf which measured 1.3 m in length! They had discovered a population of several plants (five conspicuous plants and about 10 more smaller ones). The plants were located on the floodplain of a small stream (Bullet Lake Drain), in the shade of *Populus tremuloides* Michaux and *Ulmus americana* L., at the edge of a mowed area. Although we were able to find no matching specimens in either MSC or MICH, we identified the plant as *Heracleum mantegazzianum* Sommier & Levier, a member of the Apiaceae, noteworthy for attaining heights of 4–5 m with umbels 50 cm wide (see Cover). To the best of our knowledge, this represents the first record of the species in Michigan, although the taxon is now known to occur rather frequently in southern Ontario (Morton 1978).

Heracleum mantegazzianum is native to the Caucasus region but has

become widely naturalized throughout much of Europe where it has escaped from cultivation, particularly from botanical gardens (Tutin et al. 1968, Morton 1978). In Britain, the planting of this species in gardens was advocated until it was discovered that the sap from cut stems contains furanocoumarins, compounds which, when placed on skin and exposed to sunlight, can cause severe blistering (Drever & Hunter 1970) and possibly permanent scarring (Morton 1978). Even uncut, the plant can cause skin irritation from the pustulate bristles on the stem (Morton 1978).

In the late 1940s or early 1950s, George W. Thomson had seen this species on the Bruce Peninsula in Ontario (Morton 1978). Morton (1975) first noted its occurrence along the banks of the Saugeen River in Bruce Co., Ontario. His publication elicited reports from persons who had also seen it in other Ontario locations. It is now known to have attained a wide distribution in southern Ontario and is spreading rapidly (Morton 1978). In the *Michigan Flora*, Voss (1985) alerted us to the possibility of its spread to Michigan. The United States Department of Agriculture has designated the species as a “Federal Noxious Weed” (7 CFR Part 360.200 p 342).

The occurrence of *H. mantegazzianum* on the Bouterse property represents a natural colonization from an unknown source. No deliberate plantings have been made by the Bouterse family. Their land has been in the family since 1837 (Gloria and Charles Bouterse pers. comm.). The tract extends well beyond the population in every direction, which limits the possibility of an introduction by neighbors. The rarity of the species in Michigan and the distance to any other known populations (i.e., Ontario) is suggestive of avian dispersal. Clegg and Grace (1974), however, conducted experiments in Scotland on dispersal of the species and were unable to document any instance where birds were taking the seeds, even when these were deliberately set out with other food items. Wind tunnel experiments have shown that wind could account for short-distance dispersal but would not explain long-distance dispersal (Clegg & Grace 1974). A third potential mode of dispersal is by water. In flotation tests, Clegg and Grace showed that the fruit could remain afloat for three days in an undisturbed surface before becoming water-logged. Although dispersal by water is consistent with the distribution and spread of the plant along waterways in the British Isles, the existence of it in non-waterway sites (e.g., along railways and roadsides; Clegg & Grace 1974) suggests more than one potential means of dispersal.

The stream adjacent to the Bouterse population originates in two marshy areas not more than 2.4 km north and 1.6 km west of their property. About 0.8 km east, it joins the larger Squaw Creek which eventually flows into the Red Cedar River (USGS topographic maps; Williamston, MI, 1970 and Webberville, MI, 1973). It would be of interest to monitor these downstream areas for seedling establishment. If the species spreads along waterways as quickly here as it has in Europe and southern Ontario, it might not be unreasonable to expect it someday along areas of the Grand River, of which the Red Cedar is a tributary. The authors would appreciate learning of other sightings along these waterways or anywhere else in Michigan.

Besides attaining a maximum height at maturity of 4–5 m (which is taller than our native herbaceous vegetation), *Heracleum mantegazzianum* can be distinguished vegetatively from similar species such as *Heracleum maximum* Bartram, *Angelica atropurpurea* L., and *A. venenosa* (Greenway) Fern., by the presence of conspicuous purple blotches on the stem and leaf stalks, each associated with a stiff pustulate bristle. In mature specimens, it can be distinguished from the aforementioned taxa by the fruits which often contain swollen vittae (oil tubes), usually 0.8 mm or more wide and extending 75% of the way down the fruit from the apex. Other characteristics of *H. mantegazzianum* include ternately-compound leaves with deeply pinnately-lobed and toothed segments, umbels up to 50 cm in diameter with 50–150 rays, and white petals (rarely pinkish). It can be biennial, monocarpic, or perennial and may be difficult to eradicate due to the persistent rootstocks (Morton 1978).

A voucher specimen from the Bouterse population is deposited in MSC:

MICHIGAN: INGHAM CO.: Bouterse property on S side of Bullet Lake Drain, along Harris Road S of intersection with Sherwood Road, 8 July 1991, *Shawn, Gloria & Charles Bouterse s.n.* (*MSC 330485*).

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INDEX TO VOLUMES 29, 30, AND 31

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This index follows the general format and philosophy of previous indexes. Scientific names are cited for *every* occurrence on every page, including figure legends and within the body of tables but not literature citations. Common names are not indexed. Names above the level of genus are not indexed. A full citation of authors and title is only given for the first author; citation for all other authors is given by a reference to the first author. Some apparent misspellings are included because the misspelling was the author's point; if there are others, my apologies.

NEW NAMES PUBLISHED IN VOLUMES 29-31.

Cornus ×friedlanderi W. H. Wagner **29**: 131
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On the cover: *Giant cow-parsnip* (Heracleum mantegazzianum), *with umbels measuring 50 cm across, discovered near Williamston, Ingham County, Michigan. Photographed at Wakehurst Gardens, southeastern England, by John H. Beaman, July 1985.*